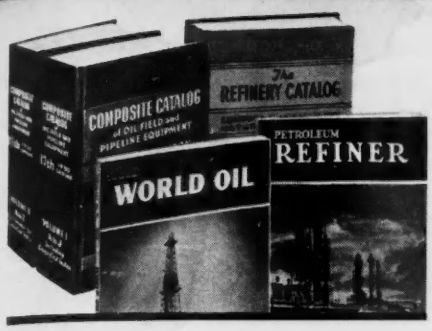

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WORLD OIL and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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Control of water and gas encroachment poses a vital problem in many old wells. On a recent job, Dowell Electric Pilot Surveys revealed areas of gas and water encroachment that were choking off production on a well. The well was then plugged back 20 feet with plastic, and plastic was squeezed around the casing shoe. Result? *Before* remedial work, oil production was 12 bbls. per day with 90% water and a gas-oil ratio of 20,000 cu. ft. per bbl. *After Dowell Service,* oil production was 50 bbls. per day with only 30% water and a gas-oil ratio of 3700 cu. ft. per bbl.

Dowell Plastics have proved themselves ideal for many workover and recompletion jobs. If necessary, the Dowell Electric Pilot is used to determine the well's permeability profile and the sources of fluid entrance. Then, the Dowell engineer uses a specially engineered bailer to spot the plastic in the right place. The plastic enters the well as a fluid . . . then becomes an impervious solid at a predetermined time. Dowell plastics provide excellent bonding and penetrating qualities that form a permanent dam against encroaching fluids.

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Ask your nearest Dowell station for complete information on these Dowell services and products: Acidizing Service, Electric Pilot Services, Plastic Service, Chemical Scale Removal Service for heat exchange equipment, Jelflake, Paraffin Solvents, Magnesium Anodes for Corrosion Control and Bulk Inhibited Hydrochloric Acid.

"Petroleum Promotes Progress"

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WHO PAYS THE BILL?

THE OTHER DAY a veteran of World War II said to me: "I am worried about all these benefits we veterans are receiving and about to receive. I wonder if the powers that be think we are all so dumb that we do not realize that these benefits must be paid for out of taxes over a long period of time.

"The older generation of today will be passing off the scene before long. Veterans, generally, are young, so actually it is the veterans and our children who must pay the bulk of the taxes to provide us these benefits. It is beginning to frighten me."

And well he can be frightened, as a recent address by Herbert Hoover would confirm. Nobody has ever denied that Hoover is an intelligent man, a studious man, though many have expressed the belief that he lacked in human warmth—this despite his record of helping the helpless of Europe.

• • •

SAID HOOVER: "No nation can remain static and survive. But dynamic progress is not made with dynamite. And that dynamite today is the geometrical increase of spending by our governments—Federal, state, municipal and local. . . .

"Twenty years ago, all varieties of government, omitting Federal debt service, cost the average family less than $200 annually. Today, also omitting debt service, it costs an average family about $1300 annually. . . .

"Beyond this is the alarming fact that at this moment executives and legislatures are seriously proposing projects which if enacted would add one-third more annually to our spending. Add to these the debt service and the average family may be paying $1900 yearly taxes. . . .

"Today, there is one government employe to about every 22 of the population. Worse than this, there is today one government employe to about eight of the working population in the U. S.

"Today a little more than one person out of every seven in the population is a regular recipient of government monies. If those of age are all married, they comprise about one-half the voters of the last presidential election. . . .

"In the long run it is the Average Working Citizen who pays by hidden and other taxes. I have made up a little table showing the number of days which this kind of citizen must work on average to pay the taxes.

	Days' Work
"Obligations from former wars	11
Defense and Cold War	24
Other Federal expenditures	12
State and local expenditures	14
Total thus far	61

"But beyond this the seriously proposed further spending now in process will take another 20 days' work from Mr. and Mrs. Average W. Citizen.

"Taking out holidays, Sundays, and average vacations, there are about 235 working days in the year. Therefore, this total of 81 days' work a year for taxes will be about one week out of every month."

The real road before us, Hoover concludes, is to reduce spending and waste and defer some desirable things for a while and he adds:

"The qualities of self-restraint,.and of integrity, of conscience and courage still live in our people. It is not too late to summon these qualities into action."

• • •

WHAT BURNS us up is that some people, many of them politicians, many of them left wing labor leaders and some "intelligensia," all claiming a corner on regard for humanity, are hell-bent on changing our type of economy for socialism and a socialized state, under the pleas for "benefits." They and some who lean their way because they hope to get something from the change either ignore or are not capable of realizing the plight of the worker if their dreams are realized.

We have only to look at England to get the answer as to what would happen.

If the United States of America should go socialistic, where would we find the capitalistic sucker to finance the adventure?

Probably some of these socialistic minded persons, in the sanctity of their inner thinking, would smile and say to themselves, "Why, you, the American people who own anything or ever hope to own anything, would be the suckers." But they won't admit this openly.

Ray L. Dudley

"Nothing but harmony, honesty, industry and frugality are necessary to make us a great and happy people."

George Washington in a letter to Lafayette, shortly before he became the first president of the United States of America.

REPORT FROM
THE OBSERVATORY

Excess Gasoline May Endanger In

By RAY L. DUDLEY, Publisher, and WARREN L. BAKER, Editor

IMPROVED CONDITIONS continued to characterize the industry's economic position during the past month, although excessive producing and refining operations remained a serious problem in California. Crude oil achieved an especially strong and favorable condition, as crude stocks were reduced at enlarged rates despite increased producing levels. Outside of California, all oversupply has been erased, and additional gains in production are an immediate necessity. Thus, prospects for the next four months are highly favorable.

Nevertheless, there were growing indications that the industry's very favorable economic position would be of short duration unless refiners curtailed gasoline yields at once. Failure of refiners to reduce gasoline yields appeared destined to result in the accumulation of such excessive quantities of motor fuel during the low consuming winter months now at hand as to seriously injure the industry's whole outlook by next March. This trouble could be avoided by proper adjustment of refinery yields, since more heating oil and less motor fuel should be manufactured. However, refiners were showing little inclination to take the necessary steps—and already may have waited too long.

• • •

TOO MUCH GASOLINE has become the industry's problem. Early next spring is the critical period. The low motor fuel consuming season has been entered with 11 million more barrels in storage than a year ago. This in itself presages that by the end of next March, when motor fuel consumption commences picking up again, gasoline inventories will exceed the all-time peak of 128 million barrels which existed last March. But unless refiners immediately curtail gasoline yields from present rates, gasoline stocks are certain to go far above 128 million barrels and then would get completely out of hand.

The situation is further aggravated by the necessity of running large quantities of crude through refining plants this winter so as to make enough distillate heating fuel to satisfy consumer requirements. The winter season has been entered with only 12½ million barrels more distillate fuel oil in storage than a year ago, of which only 7 million are located east of California and quickly available for the heavy consuming regions of the country. Inventories east of California represent an increase of only 10 percent, whereas minimum heating oil requirements are expected to be at least 20 percent above last winter. As refiners are forced to run for distillate, they cannot avoid making gasoline also.

• • •

DISASTROUS RESULTS can be the only outcome from the accumulation of such excessive quantities of gasoline storage as appears probable at this time. Gasoline prices certainly would be reduced next spring, and a slash in crude prices would assuredly follow this because motor fuel has been the only refined product in a strong price position for the past year.

Cuts in the price of gasoline and crude would seriously damage the profit picture for both refiners and producers.

• • •

TROUBLE CAN BE AVOIDED if refiners immediately curtail their yields of gasoline and at the same time increase their output of heating oils. Physically, this is a relatively simple matter, and refiners should go all out in adopting such a program. If such steps are taken immediately, refiners can prevent the accumulation of too much gasoline and at the same time make it possible to provide adequate supplies of heating oil.

Some progress in the adjustment of refinery product yields has been made recently. Gasoline yields in late weeks have been averaging 48 percent of the crude runs to stills in contrast with 50 percent three months ago. Meanwhile, distillate fuel oil yields have advanced from 16 percent three months ago to 18 percent.

Unfortunately, these adjustments do not constitute a sufficient change. The 44 percent gasoline yield which existed in October, 1948, would be much more reasonable under existing conditions. Such an

Industry's Favorable Position

WORLD OIL'S summary of the oil situation at the close of October

adjustment, and the boosting of distillate fuels to a 20 percent yield, would go a very long way toward preventing the undesirable economic condition which is certain to be created this winter under existing refinery programs.

• • •

LOTS OF PROGRESS has been made in the crude oil picture, and this phase is in a most excellent position. Despite higher producing rates, crude stocks continue to be reduced at large rates. Current volumes are very close to the minimum quantity required by the industry, and hence additional increases in production appear a must.

Almost as much crude oil was withdrawn during the first two weeks of October as during the month of September. An average of 225,000 barrels was taken from storage in September, but this stepped up to 373,000 barrels per day during the first two weeks of October as refinery crude runs were enlarged.

On October 15, the industry had 253 million barrels of crude oil in storage. This represented a reduction of 11½ million barrels since September 3, and a drop of 22 million barrels since the end of May.

With crude oil in such excellent shape, probable excessive gasoline supplies are the only factor which darkens the horizon for next year as far as the area outside of California is concerned.

• • •

ANOTHER PRODUCTION BOOST for December appears necessary. Recent large withdrawals from crude stocks and anticipated higher consumption presages that crude inventories are to be reduced further in November despite the scheduling of bigger production volumes. This would lower crude storage to the bare minimum on which the industry can operate, making further dependence on stocks impractical.

Consequently, additional substantial gains in production seem an absolute necessity for December, as crude output must be brought to a level equal to requirements. Texas producers, of course, will benefit most from any increases in production volumes.

CALIFORNIA'S OUTLOOK remains dark. While some relief is in prospect for heavy fuel oil, currently the No. 1 headache of the California oil industry, the situation cannot improve substantially unless producing rates are curtailed by approximately 100,000 barrels per day. This appears improbable since the state is without conservation laws to enforce such action.

Definite plans promulgated for moving about 6 million barrels of West Coast heavy fuel oil to East Coast consumers, made possible by a difference in current prices, will only slightly alleviate the storage problem which has been plaguing California refiners. Currently, California heavy fuel prices are 40 to 50 cents per barrel below recently advanced Gulf Coast postings, and this difference may attract additional purchases for East Coast shipment. However, only reduced producing rates can bring about a permanent improvement in the California picture.

As of October 15, stocks of residual fuel oil in California totaled 39½ million barrels, an increase of 18½ million barrels as compared with a year ago. Since August 6, California stocks of heavy fuel oil have increased by 3 million barrels, or an average of better than 40,000 barrels daily.

Other California stocks also have increased. Today gasoline stocks are 4½ million barrels above year ago levels; distillate fuel inventories are 6 million barrels greater; and crude stocks are 10½ million barrels larger.

Drastic cutbacks in production of heavy crudes have been made voluntarily by a number of California companies, principally major firms, during the past year. However, unrestrained production in some fields has tended to partially offset this curtailment. Flush production of the new Placerita field, for example, has developed from a daily rate of less than 1000 barrels in April of this year to a present volume of around 34,000 barrels. This oil, ranging in gravity from 14 to 27 degrees, contains a high percentage of residual fuel oil, much of which currently is being dumped on the market by small refiners who have insufficient storage facilities. Existence of this distress heavy fuel undoubtedly has been instrumental in bringing on recent cuts in posted prices of this product in the state.

A RIG SIDE CHAT

about Baker Retainer Production Packers

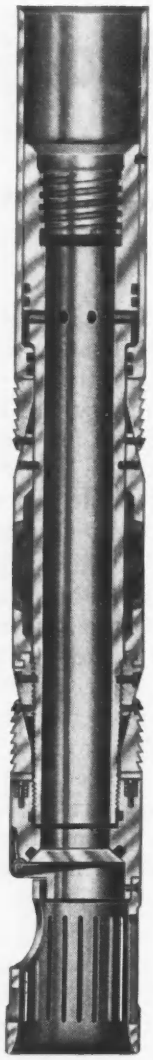
What we want to talk about today is how the Baker Production Packer is set securely in the casing, anchored against either upward or downward movement, with the tubing production string left free from the packer. The tubing is run through the body of the packer for production, and is free to be pulled at any time without disturbing the packer. In the typical application drawing (far right) the packer has been set and anchored to the casing by the two sets of opposing slips, with the Hycar packing unit sealed-off against the casing and retained in position by lead seals.

We want to produce from a zone below the packer so we make up the string with a Baker Perforated Production Tube on bottom (with operator's tubing to provide an additional stinger, if desired); above is a Baker Multi-V Tubing Seal Nipple; next a No Left Turn Latching Sub; and above that comes the tubing. Now we run-in the well until the Latching Sub engages in the top of the packer. The engaged Sub automatically positions the Multi-V Tubing Seal Nipple accurately in the smooth bore of the packer, and with 5 Hycar rings facing up and 5 more facing down, a perfect seal is obtained between the tubing string and the packer bore. Meanwhile, the Perforated Production Tube, as it was run through the bore of the packer, has unseated the Flapper Valve and now holds it in open position.

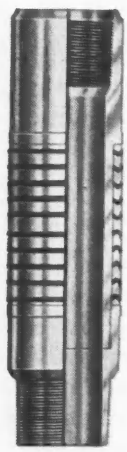
It's as simple as that, and we are ready to produce through the ⅜-inch holes in the Perforated Production Tube. These holes prevent junk, debris and large pieces of shale from entering and clogging the production string; and the total area of all holes is equal to or greater than the area of the tubing string.

When the tubing string is pulled at some future time, the Flapper Valve in the lower end of the packer body snaps back into the closed position and maintains a fluid-tight seal against upward pressure from below. The packer is not disturbed by pulling the tubing string, but remains packed-off against the casing ready for future operations.

This is only one of the many applications of the Baker Retainer Production Packer for single-zone or multiple-zone production; for selective testing and acidizing; for protection of casing from pressure or from destructive fluids, or gases; and other profitable uses.

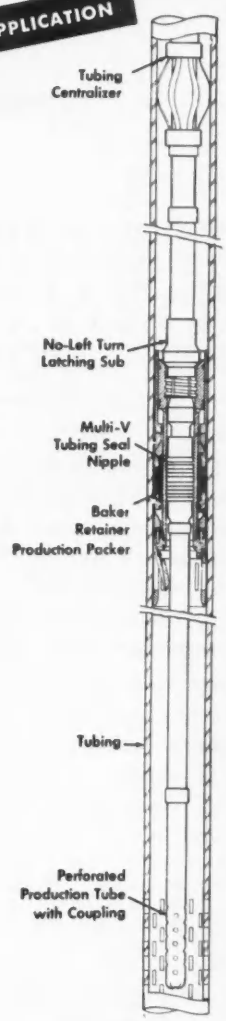


Baker Model "D" Retainer Production Packer Product No. 415-D



BAKER TUBING SEAL NIPPLE, MULTI-V TYPE, which effects a fluid-tight seal between the tubing string and the bore of the Packer.

TYPICAL APPLICATION



Single zone hook-up with production string anchored to packer, for: (a) keeping production string in tension to eliminate "tubing breathing" during the pumping cycle; (b) producing by flowing, without imposing excessive weight on packer to hold Tubing Seal Nipple positioned in packer bore; (c) making high pressure injection of gas or fluid for re-pressuring or secondary recovery.

Production string is run-in until No Left Turn Latching Sub rests on top of packer, indicated by drop in weight on strain gauge or weight indicator. The production string is then raised about 5 feet, and the zone washed and brought in, if it will flow.

If you would like to continue this rig-side chat at any well where you have a production packer problem, call the nearest Baker "Service Engineer." He will have helpful suggestions, and he is as near as your telephone . . .

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BAKER OIL TOOLS, INC. HOUSTON • LOS ANGELES • NEW YORK

BAKER

RETAINER PRODUCTION PACKER

PRODUCT NO. 415-D

The Changing Panorama

Congressional Tact—I Murdered You, Pal!

REKINDLING the fires of ancient hates in the name of sweet patriotism is the classical earmark of demagoguery.

> Who, then, but a demagogue would say this: "Oil is a natural resource. This natural resource was stolen from the Mexicans by the American oil interests and the oil kings of other foreign nations. Doing business with the Mexican politicians of days gone by, the foreign oil interests came into Mexico, took over its lands for little or nothing, made slaves of the Mexican people, even murdered them in the grasp for the profits resulting from the sale of the oil which poured from the Mexican earth. These same foreign interests fomented revolutions and in general extended peonage and poverty in that country."

Sounds like sewage from a capitalist-baiting, Stalin-serving Mexican Commie, doesn't it? But no, the words were bellowed from beneath the cloak of Congressional immunity by Congressman Wolverton, duly elected representative of the people of New Jersey.

And what would you say was the purpose of the Congressman's malignant mumbo-jumbo? Well, he explains it a couple of hisses later, right here in the Congressional Record. He says: "We need Mexico's lasting friendship."

That may be one way to promote "lasting friendship," but while admitting of an abysmal ignorance of the intricacies of international diplomacy, we can think of better salve for old wounds than a dousing of Wolverton venom. Even if the words were true, we can't imagine one individual saying to another: "How's about you and me being great pals? Oh, by the way, old buddy, remember the night I broke in your house, stole your money, killed your children, and kidnaped your wife? You'd forgotten? Oh, you mustn't. It happened this way . . ."

Crude Oil May Become Good Uranium Source

CRUDE OIL may some day become an abundant source of uranium and help launch the world into the atomic age.

Argentine scientists claim that they have discovered measurable quantities of uranium in crude oil now being produced in Mendoza Province. The report was checked back with American technologists who say that the existence of uranium in crude oil has been known for some time. Indeed, this radioactive element associated with oil-bearing formations makes a certain type of well logging possible today.

The presence of uranium in asphaltic and other bituminous veins or outcrops has been reported in other parts of the world. In Argentina, scientists measured the radioactive intensity of outcrops at Neuquen and San Martin, and since these were located relatively close to the producing oil field at Mendoza, it was decided to analyze the crude being produced there.

Results of the analyses have caused the Argentine government to order an intensive investigation as to the probable source of the uranium content in the crude and also how to extract the element if it is found to exist in the crude oil in commercial quantities.

Crude oil may well be called the "miraculous mineral." Not only does it provide energy and lubrication, but it is the source of a thousand and more industrial and household products which have become commonplace to our way of living.

Federal Versus State Control of Oil Lands

WHILE the federal government seeks to control the oil on the continental shelf, many oil companies and independent operators strongly feel that offshore development would be much less effective and successful under federal than under state administration, judging by experience with both. Operators have long and satisfactorily dealt with state governments and conservation agencies. They also have dealt with the federal government in connection with federal lands, but have found in those cases delays, red-tape, and other obstacles to be expected in a centralized, remote control.

A recent example of federal administration supports the widespread opinion that it is not conducive to the most active development. Regulations of the Bureau of Land Management, Department of the Interior, heretofore have provided that if a qualified applicant files for a federal oil and gas lease and the lands at that time are not within any known geological structure, the applicant shall be entitled to a lease upon payment of rentals and other fees. There are 10,000 or more such applications pending, some filed several years ago. The department is simply delaying action, it is charged. Recently, Assistant Secretary of the Interior Davidson instructed the Bureau of Land Management to prepare a regulation providing for rejection of all such applications if during any such delay the lands have been "proved up" by a nearby well or otherwise. The leases would then be auctioned off to the highest bidder. The objective is more revenue for the government.

If such regulation is put into effect, the bureau may hold up a qualified applicant until some nearby well is drilled. If it is a producing well, the bureau will reject the application and offer the lease for bids. If it is dry, the lease will be worthless. Either way, the applicant loses.

Operators say such a policy would destroy initiative and enterprise and force independents out from the public domain, unless corrected by the Secretary of Interior himself, the courts, or Congress.

A bill has been pending in the House to require competitive bidding on all oil and gas leases issued by Department of Interior on "acquired lands." There would be no distinction as to whether the land was or was not on a "known structure." However, this bill was tabled in committee, which perhaps revealed the attitude of Congress on the principle involved.

Too Many Competitors Rule Out Oil Monopoly

THE TREND of governments over the world toward nationalization and restrictions of free enterprise was deplored by Robert L. Minckler, president of General Petroleum Corporation, in a recent speech in Los Angeles. Speaking of the U. S. domestic situation, he stated that "the oil business is about the favorite whipping boy of our politicians. We are supposed to be a monopoly, for example. Just how you work into a monopoly the 13,475 separate companies in the oil producing business, the 400 companies in refining, the 650 transportation companies, the 20,000 wholesale and 250,000 retail selling companies and individuals is never explained."

The Welex Jet Process of casing perforating gives up to 300% greater penetration than any other practical method of perforating. Yet, with all its tremendous energy, the Welex Jet provides the safest method of well perforating ever used.

The fact that the Jet method of well perforating is the safest, as well as the most effective, is not just a fortunate coincidence. During years of exacting technical work in perfecting the Jet Process, Welex regarded the safety of your well as being of top rank importance. The charge carrier, or gun, as designed by Welex, assures you of full protection for your well and casing. Rigid and exhaustive tests by Du Pont (manufacturers of the Welex Jet charges) prove that Welex Jet charges are virtually insensitive to heat or shock and may be detonated only by means of the electrical circuits provided on the Shooter's control panel.

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Monthly News Analysis

REFINERIES REGAIN NORMAL THROUGHPUT . . . IMPORT FIGHT CONTINUES
PIPE LINE DIVORCEMENT SOUGHT . . . API REORGANIZATION CONSIDERED

Increased Allowables Reflect Rising Demand for Petroleum

Continuance of recent months' rising demand for petroleum was reflected in the Texas Railroad Commission order increasing Texas crude production allowable to 2,286,175 barrels daily for November, up 137,606 daily from October. All fields will be permitted one more producing day in November—18 for the East Texas field and 20 for other fields.

The commission continued policy of non-discrimination between sweet and sour crudes, although some purchasers in hearing on November allowables had said they would have to import sweet crudes unless more were made available in Texas in ratio to sour crude.

Other states of Southwest also have been gradually increasing allowables in recent months.

Refineries Regaining Normal Capacity Above Input Rates

Although the U. S. operated available refining facilities almost at full capacity at times during the war and early postwar period, there has been much construction of new units and considerable current work remains to be completed. Meanwhile, runs to stills have been curtailed in this year's business letdown. Consequently, the industry is getting back toward a normal prewar basis of having substantial capacity above actual refinery operating rates. Operations lately have been at the rate of around 82 to 85 percent of capacity, though expected higher runs later this year for meeting heating oil demand may require operations around 90 percent of capacity.

The U. S. Bureau of Mines recently issued its new annual survey of U. S. refineries and reported that large-scale construction in 1948 had increased crude processing capacity to 6,438,995 barrels daily as of January 1, 1949, from 6,034,252 daily on January 1, 1948. That gain of more than 400,000 barrels occurred although number of refineries decreased to 375 from 390. Capacity of average refinery therefore increased during 1948 to 17,171 barrels daily from 15,472.

Of the expansion of facilities in 1948, said the bureau, 79 percent was accounted for by the Texas Gulf Coast, Louisiana Gulf Coast, the East Coast, and the Indiana-Illinois-Kentucky district that supplies the Middle West.

Capacity building on January 1, 1949, amounted to 341,500 barrels daily, only 25,750 barrels lower than one year previously and second highest on record for beginning of a year. This construction like the bulk of that in 1948 was largely in the four districts mentioned in the preceding paragraph.

The total of 6,438,995 barrels daily of installed U. S. refinery capacity at beginning of 1949 included 6,230,505 barrels operating and 208,490 barrels daily of shut-down capacity. The shut-down capacity was about the same as one year previously.

At the middle of 1949, API refinery statistics indicated about 6,340,000 barrels per day of U. S. refinery capacity in operation—an increase of about 110,000 barrels daily for the first half of 1949.

While the postwar refinery construction is providing a gradually increasing margin of capacity above actual operating rates, net gains in capacity are held down by the fact that a substantial part of new capacity is merely replacing obsolete and worn out equipment. Although the war caused an accumulation of replacement needs, which the industry has been taking care of, there is even in normal times a relatively rapid obsolescence of refining facilities as well as growth in oil use and need for additional refining capacity. Consequently, refinery construction and modernization may be expected to continue on an important scale even after the meeting of special postwar needs, especially if demand for petroleum products continues to increase as anticipated.

LP-Gas Industry Is Planning National Promotion Program

The liquefied petroleum gas industry is working on plans for a nationwide program for promotion of its products and services. The program will include broad scale advertising and publicity campaigns, employe training courses, and special public relations activities. It will be financed by voluntary industry contributions.

Cooperation in the plan has been pledged by Liquefied Petroleum Gas Association and Natural Gasoline Association of America, and other groups expected to participate include National Butane-Propane Association, Gas Appliance Manufacturers Association, and California Natural Gasoline Association.

A planning committee representing all segments of the LP-Gas industry, from producers to dealers, has recommended spending $963,000 in 1950 to promote LP-Gas sales and $1 million in each of the succeeding four years. These amounts compare with Oil Industry Information Committee budgets of $1,850,000 for 1948 and $1,500,000 for 1949, covering all phases of the U. S. oil industry but aimed primarily at public good will rather than sales.

The proposed $963,000 LP-Gas program for 1950 includes $700,000 for advertising, $98,000 for publicity, $90,000 training program, and $75,000 for special public relations activities.

Liquefied petroleum gas, also known as bottle, tank, butane and propane gas, is now used in over 5½ million homes beyond the city gas mains. It also has hundreds of agricultural, industrial, and commercial applications.

Independents Will Continue Vigorous Fight on Imports

The question of U. S. oil imports remains one of great concern within the industry. Independents will continue their vigorous fight for import restrictions, it was asserted at the annual meeting of the Independent Petroleum Association of America at Fort Worth in early October. Leaders of the organization declared they were disappointed but undaunted by the one-vote defeat by the U. S. Senate of the Thomas amendment to the Reciprocal Trade Agreement Act, which would have limited imports to 5 percent of domestic demand. The group will undertake a new fight to curb the imports.

Among other moves, the independents will strongly support new legislative proposals with similar objectives as the Thomas amendment, as embodied in separate bills or amendments to more general bills. The association also is strongly opposing use of U. S. taxpayers' money for financing British or other foreign oil industry facilities which would be above recovery needs and set up competition that would impair the U. S. domestic oil industry. In this connection, the in-

dependents have misgivings that devaluation of foreign currencies will lead to increased selling of foreign oils in the U. S.

The State Department has taken a stand against legislation restricting petroleum imports, and this action, in the face of a threatened huge influx of foreign oil by 1953, has thrown the import issue into critical focus.

Representative Ed Gossett of Texas introduced a bill for an oil import quota plan, and the State Department's dissent was conveyed in a letter by Assistant Secretary of State Willard Thorpe to Gossett, who is chairman of the Texas delegation's import committee in Congress. Thorpe said:

"Restrictions on imports of petroleum are unnecessary and would be both unwise and detrimental to the interests of the petroleum industry of the U. S. I find it difficult to conclude that imports have been a major factor in curtailment of domestic production. The recent record has been much more an adjustment to domestic conditions."

Thorpe argued that the 229,000 barrels a day excess of imports over exports in oil for the first half of 1949 was small when compared with total domestic production or with the production decline in Texas. Previously, the State Department had asked the chief importing companies to state what quantities of oil they are bringing into the U. S. The answers, said Thorpe, for the ten companies representing 86 to 92 percent of the foreign oil trade, added to: third quarter of 1949, 566,000 barrels a day; fourth quarter, 674,000; first quarter of 1950, 706,000; second quarter, 602,000.

Thorpe commented on these figures: "The combined estimates for the ten companies indicate a steady but moderate increase in imports of crude oil during the balance of 1949 and the first half of 1950. They show a sharper increase in imports of refined products during the winter months with a substantial decline thereafter. The increase in imports of refined products is, however, almost wholly accounted for by heavy fuel oil. Importers of heavy oil indicate they cannot get enough of it at competitive prices to meet their market requirements. They also indicate that in view of the substantially lower price for this product as compared with crude oil, imported heavy fuel oil does not compete with markets for the domestic crude oil output."

Independents have sharply attacked this contention. They assert that excessive residual imports have caused oversupply and depressed prices of residual in the U. S., pushing the residuals of American refiners out of their markets and thereby wiping out markets for domestic crude production.

Fewer Tankers Are Inactive And Rates Show Improvement

Inactive tankers gradually are being drawn back into service, but full utilization of the carriers is not likely at prevailing low rates. There are still about 150 tankers under U. S. flag tied up at various ports, as compared with 220 idle vessels last June and about 180 in September.

Meanwhile, during the last five months about 20 tankers have been withdrawn from service and scrapped or converted to dry-cargo carriers. A total of 95 tankers actually returned to service, but 39 others went into layup.

An average, but not general, rate increase of around 2 percent is credited with causing a number of oil companies to break tankers out of layup. Fuel oil and crude oil fixtures were made in one recent week at about 40 percent off the old official scale, as compared with 45 percent off for the preceding week, and clean fixtures went up from 37½ percent below scale to 35 percent below. A further stepup to about 25 percent off scale would be necessary to entice many more tanker operators to run.

Some doubt still exists, too, as to the effect of sterling devaluation on the carriers. Many industry economists believe foreign flag carriers may be somewhat benefited by devaluation at the expense of the American ships.

Surplus Stocks in California Show Need for Production Cut

California's petroleum industry now has surplus stocks of gasoline and distillate fuel oil as well as residual fuel oil, according to the Oil Producers Agency of California, and in order to keep inventories from getting farther out of line with requirements, production of crude oil should be lowered to about 825,000 barrels per day, compared with recent output of nearly 900,000 daily, a reduction of 75,000 daily.

The agency in a report made public about October 1 stated that total supply of petroleum then was 115,000 barrels per day greater than total demand. It added, however, that some seasonal increase in demand for fuel oils was in prospect, while Bunker C fuel oil in California enjoyed a 25 cent per barrel price advantage compared with the Gulf Coast, thus promising a pickup in demand for that product. A reduction of 75,000 barrels daily in supply therefore was suggested as perhaps enough to eliminate wasteful additions to storage of crude or products.

With the peak of seasonal demand for gasoline past, stated the report, the California industry had 19,500,000 barrels of gasoline in storage, compared with 13,769,000 barrels at the end of September a year ago. Stove and diesel peak seasonal demand was yet to come, but the industry had 14,500,000 barrels in storage compared with 11,226,000 a year previously, and demand so far in 1949 had been less than in 1948. Stocks of residual fuel oil were 40,114,000 barrels compared with 21,000,000 a year before. From beginning of this year to September 17, crude stocks in California increased only 2,239,000 barrels, with production going into refinery stills. But stocks of products in the same period increased 22,500,000 barrels, with supply of products exceeding demand.

In seven weeks ended September 17, California's total supply averaged 976,000 barrels daily, including about 900,000 daily of crude, said the report, while total demand was 861,000 daily, leaving 115,000 barrels per day going into storage, compared with an average increase of 91,000 barrels daily in stocks for the first seven months of this year.

Pipe Line Divorcement May Be Sought by Justice Department

The U. S. Department of Justice has begun collection of evidence on which it is studying possible legal action for divorcement of pipe lines from integrated companies. It recently sent two field men out to collect statements from pipe line shippers as to any discrimination in use of the lines. One investigator interviewed jobbers and products line users along the Eastern Seaboard, while another interviewed 40 independent producers in the Southwest.

Should DJ seek grand jury indictment and trial, its case likely will be based chiefly on evidence gathered in connection with products lines. These lines, however, unlike crude lines, do not have clear public carrier status, and action might be postponed for that reason. Independent producers generally, it is understood, are satisfied with present management of crude lines, since they are now relieved of the necessity of gathering and transportation from their well sites. In fact, their oil is sold virtually at the wellhead; therefore problems of receiving space in the lines do not arise.

The case is somewhat different with products lines. One of the lines investigated by DJ agents is the Plantation line, running from Baton Rouge via Atlanta to Greensboro, N. C., and owned by Standard Oil Company (N. J.) and Shell Oil Company. South Carolina distributors have told DJ agents that their competitive market position depends on access to this line by their suppliers and that some of these suppliers cannot get tenders into the line, thus causing them to consider withdrawing from inland areas of the state. Such action, it is said,

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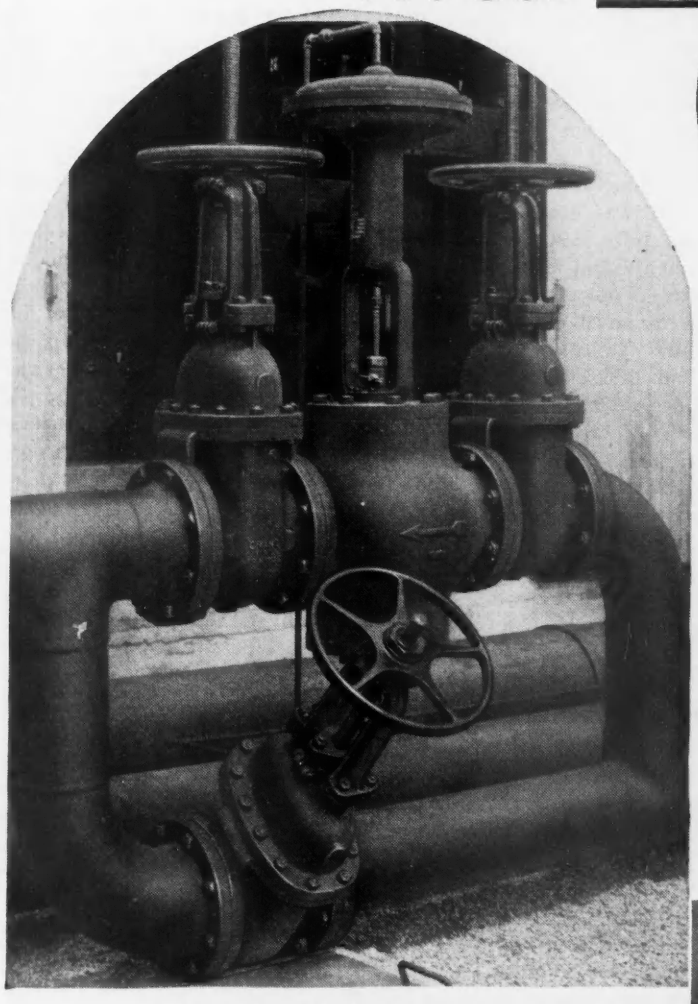

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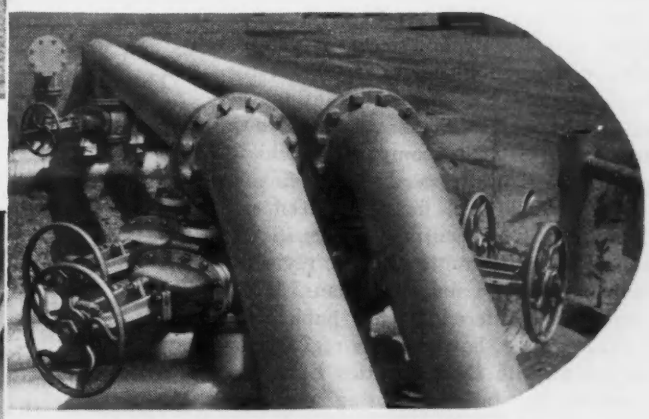

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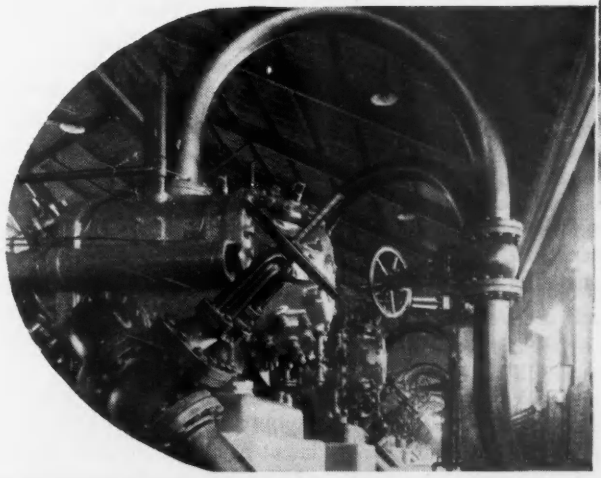

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would make these inland distributors non-competitive with Shell and Jersey jobbers because of extra cost in trucking products from deep water at Wilmington. The situation is being studied as a possible basis for legal action on the grounds of unfair competition and restraint of trade.

A divorcement bill was introduced in Congress early in 1949 by Senator Gillette of Iowa, but it had no strong support.

Johnson Bill Would Give FPC New Powers Over Gas Industry

Possibilities for retardation of natural gas industry expansion were seen by some observers in the bill introduced in the Senate October 19 by Senator Lyndon B. Johnson of Texas, calling for expansion of Federal Power Commission's control over financing of interstate natural gas pipe lines. The bill was referred to the Senate Interstate and Foreign Commerce Committee, of which Johnson is a member, just before Congress adjourned, and Johnson said he was hopeful the bill would be considered early next year after Congress convenes again.

The Johnson bill (S.2746) would prohibit issuance of securities by natural gas companies without prior approval by FPC. Under present procedure, a company undertaking a pipe line project must apply to FPC for a certificate of public convenience and necessity authorizing construction and operation of the facilities, and FPC before granting the certificate studies testimony, exhibits, and reports of the company, including general data on proposed plan of financing. But details of financing need not be set forth in securing the certificate, and after certificate is granted, revisions may be made in financing plans. If securities are offered to the public, the company must, however, file registration statement with the Securities Exchange Commission, fully disclosing pertinent facts and information about the financing and the company, for consideration of investors, as in the case of other publicly sold securities.

Johnson declared that the prevailing procedure leaves a regulatory gap that may permit "ill-advised financing." It is possible, he said, for securities to be issued on the basis of asset values which have no reasonable relationship to present or prospective earning power and thus for highly speculative securities to be put into commerce.

Johnson said he was advised such evils do not exist in the interstate gas industry but declared they should be prevented for the future, in view of similar evils that formerly existed and had to be corrected in the electric utility industry.

Questioned regarding the Johnson bill immediately after it was introduced, some representatives of the natural gas industry said that expansion of facilities might be retarded by increased regulatory powers for FPC and that financing might be made difficult, possibly to detriment of investors, by necessity of dealing with two government agencies in that connection. There is already much regulation, red tape, and delay in dealing with FPC, it was stated, and under the Johnson bill, FPC would make new requirements and have discretionary or arbitrary powers, imposing its own judgment on soundness of business propositions. Actually, it was further pointed out, FPC already is achieving to some degree, indirectly, the regulation sought by Johnson. For it considers financing plans before granting certificates for construction of facilities, and has even gone so far as to say that if securities were sold, it would require that they be sold at open competitive bidding.

Changes in API Organization Are Considered by Directors

A new organizational setup and new leadership were in prospect for the American Petroleum Institute after William R. Boyd, Jr., had informed numerous friends and directors of the API that he would not run for reelection as Institute president. Boyd is approaching 65 and plans to retire, it is said.

The committee on organization of the API board of directors, headed by A. Jacobsen, president of Amerada Petroleum Corporation, contemplated recommending to the board that API in the future be headed by an honorary chairman of the board and a paid president. Closing of Dallas and Los Angeles offices also was contemplated under a plan to consolidate in one location all offices, except for leaving in Washington the Transportation department and representatives of the president and of the American Petroleum Industries Committee.

Under these proposals, the nominations committee of the API board of directors, headed by George A. Hill, Jr., president of Houston Oil Company, was confronted with the responsibility of choosing a nominee for chairman of the board and a nominee for a successor to Boyd as president. For the proposed post of board chairman the committee was reported considering L. S. Wescoat of The Pure Oil Company and John M. Lovejoy of Seaboard Oil Company. But the committee was without a nominee for presidency after several favored prospects eliminated themselves from consideration.

States and Industry Oppose Federal Claim to Tidelands

The petroleum industry early in October presented its hardest-hitting and most extensive presentation protesting U. S. government claims to the submerged oil lands of the Continental Shelf. Before the Senate Committee on Interior and Insular Affairs, under the chairmanship of Senator O'Mahoney of Wyoming, a score of industry officials testified and were joined in their plea by another score of representatives of the Attorneys-General Association.

Two witnesses opened the hearings for the government—Secretary of Interior Krug and Solicitor General of the U. S. Perlman. Thereafter, industry and state officials took four full days to pile up the argument and evidence against the government's claims. The senators conducting the hearing were clearly impressed.

In 1949 session, now adjourned, two Senate bills, claiming tidelands for federal government, showed little chance of passage by either Senate or House. Two Senate bills for federal quitclaim of title had good chance in both houses but probably could not have survived certain Presidential veto. Similar deadlock is a possibility when Congress convenes in 1950.

In October hearings government spokesmen reiterated that U. S. had a "right" to submerged lands; that states sought to "deprive" U. S. of its interests.

Arguments offered by spokesmen for states and the industry included the following:

1. Oil of Continental Shelf can be developed more efficiently and economically by the experienced and remarkably successful private U. S. petroleum industry than by government, and states have proved more efficient than federal agencies in administering such lands.

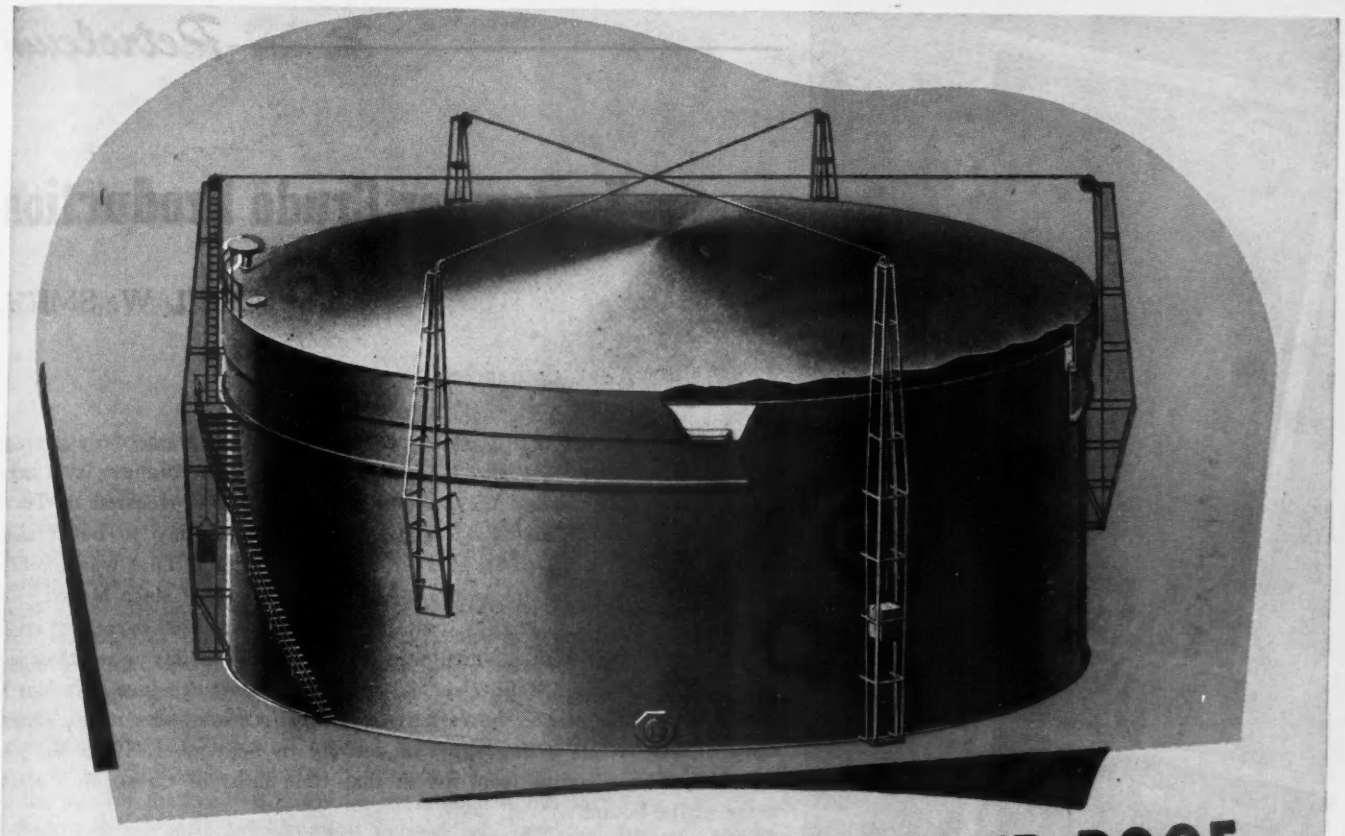
2. Federal "fencing off" of oil lands as government reserves would leave them undeveloped and useless for national emergency, whereas unrestricted competition by many private operators would bring active development.

3. Offshore operations already have reached advanced stage without question until recently of validity of state leases.

4. Industry has not been selfishly exploiting tidelands oil, as charged, having spent $200 million in Gulf to date while producing only $1.3 million worth of oil.

5. States are devoting tidelands revenues to schools, parks, etc., and would suffer great financial loss if deprived of this long established and needed source of funds.

6. Tidelands seizure would be precedent for later nationalization of other state and private properties.



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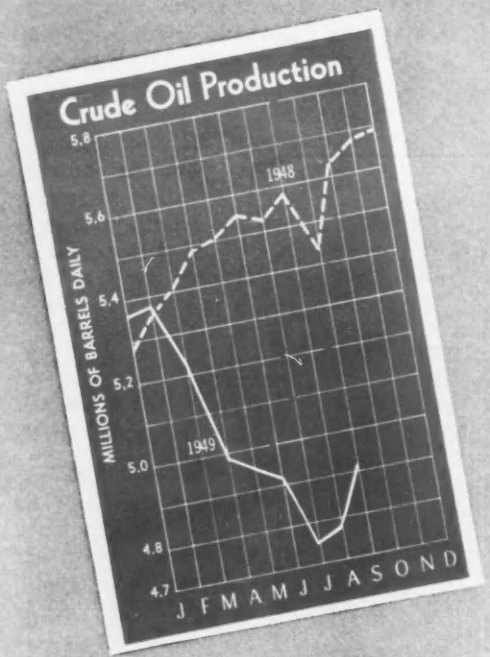
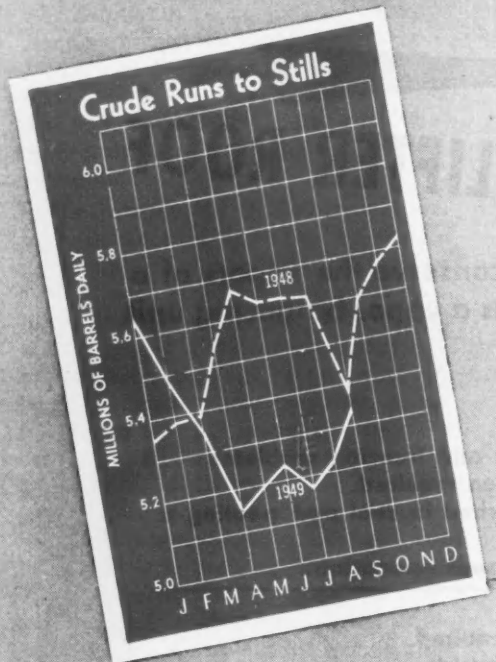
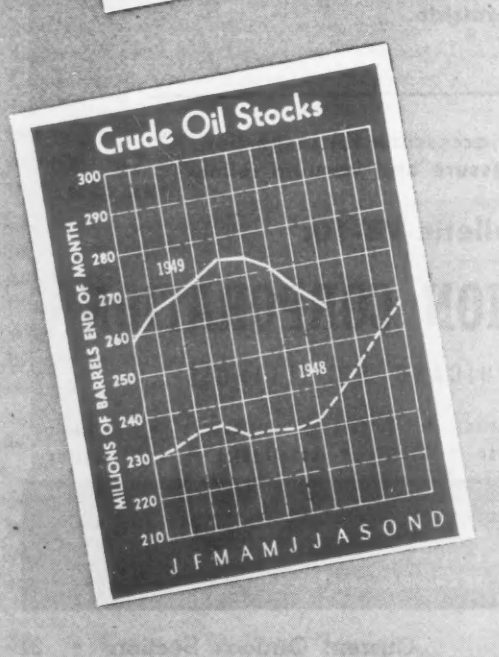






September Crude Production

By CECIL W. SMITH

AN INCREASE of 142,000 barrels a day boosted U. S. daily average crude production to 4,910,000 barrels in September, the highest level since June. The major part of the nation's production hike occurred in Texas where wells were allowed to produce an additional day to boost daily output 130,500 barrels to an average of 2,001,000 daily. That was the first time Texas had been back in the 2-million-daily bracket since March.

Refiners charged their stills with an average of 5,339,000 barrels of crude a day during the month, which was 118,000 barrels a day more than had been run in August. Refineries had not been so active since last March. An accompanying table shows that September's crude runs to stills were only 37,000 barrels a day short of activity in September, 1948, but that is hardly a fair comparison, for at that time most of California's plants were strike-bound.

Although producers were putting crude into tanks at an increased rate during the month, refiners were taking it out at an even faster clip and the net result was a reduction of 5,649,000 barrels in crude stocks. Total inventories amounted to 258,897,000 barrels at the close of the month—21,595,000 barrels higher than they had been a year before, but at a point many in the industry believe to be about correct. However, later reports show that stocks dropped to 253 million, which would indicate that production rates must be further increased.

September's gasoline production was unchanged from August's rate, but as more crude was processed it showed that at last refiners were starting to reduce their yields of this higher-priced product. Even though the percentage take of gasoline was lowered in September, a comparison with a year ago shows at a glance how relatively high gasoline yields still were.

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1948:									
January	5,283	5,348	229,842	2,328	102,167	1,082	39,788	1,278	36,260
February	5,353	5,380	231,419	2,264	110,999	1,127	33,019	1,295	35,602
March	5,406	5,387	234,164	2,252	111,949	1,050	30,570	1,307	34,192
April	5,484	5,540	234,506	2,396	109,289	978	32,564	1,303	35,527
May	5,502	5,668	231,318	2,486	108,552	992	38,551	1,314	41,123
June	5,544	5,632	231,412	2,529	104,518	998	45,835	1,280	44,213
July	5,522	5,631	230,955	2,494	98,839	994	56,045	1,264	49,448
August	5,577	5,621	231,954	2,532	95,445	1,038	65,887	1,248	55,009
September	5,435	5,376	237,302	2,416	90,518	961	73,854	1,154	58,662
October	5,632	5,594	243,972	2,490	92,426	1,069	79,992	1,268	61,456
November	5,675	5,672	250,066	2,551	95,589	1,081	80,658	1,277	64,865
December	5,688	5,720	256,254	2,626	103,697	1,106	71,475	1,299	64,021
1949:									
January	5,365	5,641	258,648	2,538	116,621	1,063	61,584	1,348	62,506
February	5,376	5,480	265,216	2,484	126,054	1,004	53,937	1,282	59,396
March	5,224	5,352	269,341	2,470	127,443	933	48,923	1,258	58,190
April	5,012	5,141	272,520	2,494	125,351	846	51,231	1,147	59,668
May	4,972	5,195	273,912	2,585	121,602	813	57,442	1,138	63,575
June	4,903	5,162	274,691	2,597	114,041	771	64,730	1,041	64,888
July	4,704	5,173	267,586	2,613	111,217	835	71,553	1,040	66,084
August	4,768	5,221	264,546	2,591	105,454	886	75,696	1,055	68,167
September	4,910	5,339	258,897	2,590	103,805	941	83,198	1,075	67,982
Sept. 1949 Change:									
In Month	+142	+118	−5,649	−1	−1,649	+55	+7,502	+20	−185
In Year	−525	−37	+21,595	+174	+13,287	−20	+9,344	−79	+9,300

Trends in U. S.

At Highest Level Since June

Statistical Editor

September's runs to still were 37,000 barrels a day less than those of a year ago, yet they daily yielded 174,000 more barrels of gasoline.

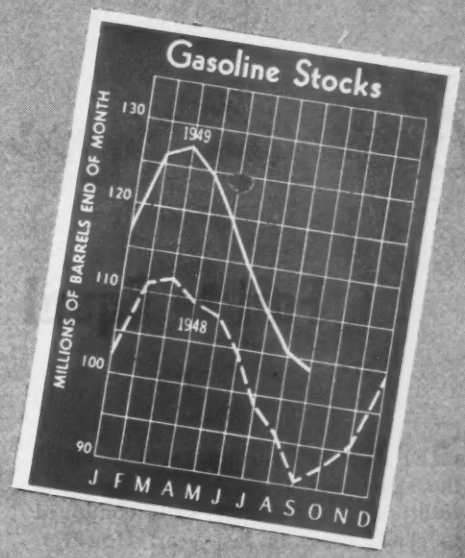
Stocks of finished and unfinished gasoline totaled 103,805,000 barrels at the close of the month. This showed that reductions in these inventories had amounted to only 1,649,000 barrels during the entire month, and that gasoline stocks were just about to start their annual trek upward. Stocks were 13,287,000 barrels or almost 15 percent higher than they had been a year earlier, but excluding California's excessive stocks, the rest of the nation's totaled about 10 percent higher.

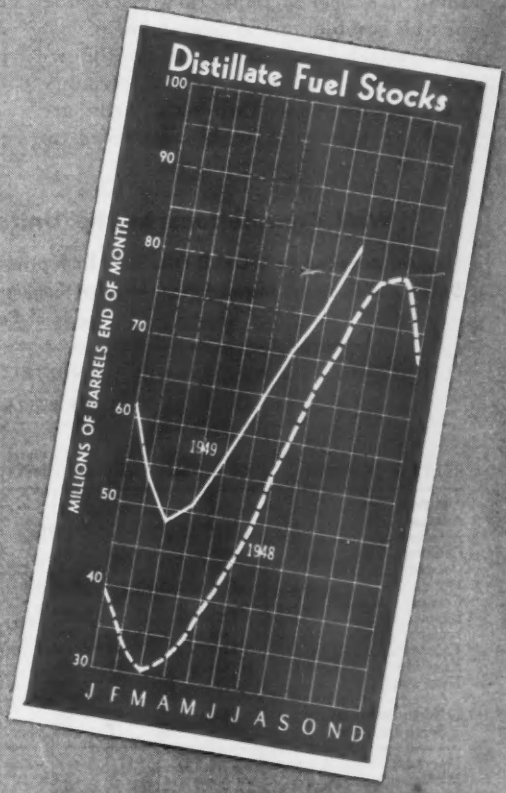
A welcome gain of 7,502,000 barrels was made to distillate fuel oil stocks during September upping the total to 83,198,000 barrels. That amount was 9,344,000 barrels or 12.7 percent more than was being held a year before. California was also holding a big share of distillate, and east of the Rockies had only 8.7 percent more than it did last year.

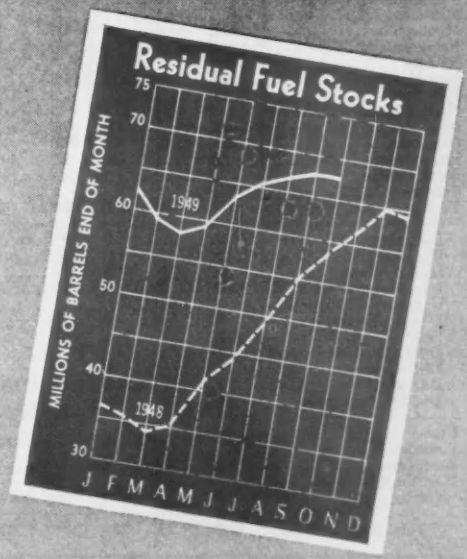
A completely different situation existed with residual fuel oil stocks. Although the U. S. total was 67,982,000 barrels at the end of the month, and amounting to an increase of 15.8 percent from last year, 40 million barrels or 58 percent were on the West Coast. Residual stocks in rest of the nation actually were 26 percent less than they had been at the end of September, 1948.

State Crude Oil Production
(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL FIRST NINE MONTHS		
	Sept., 1949	Aug., 1949	Sept., 1948	% Diff. Sept., '48-'49	1949	1948	% Diff. '48-'49
Alabama	1.4	1.2	1.3	+ 7.7	333	350	— 4.9
Arkansas	75.2	76.9	87.5	— 14.1	22,203	23,598	— 5.9
California	894.0	903.3	766.5	+ 16.6	252,682	252,963	— 0.1
Colorado	64.8	66.2	47.3	+ 37.0	17,971	12,621	+ 42.4
Florida	1.1	1.5	0.8	+ 37.5	355	214	+ 65.9
Illinois	180.7	183.8	179.3	+ 0.8	48,140	48,108	+ 0.1
Indiana	28.1	27.5	21.2	+ 32.5	6,902	4,673	+ 47.7
Kansas	257.0	252.6	310.8	— 17.3	75,435	82,418	— 8.5
Kentucky	23.3	23.0	23.5	— 0.9	6,237	6,398	— 2.5
Louisiana	506.2	499.1	502.1	+ 0.8	140,367	134,000	+ 4.8
North Louisiana	119.8	116.6	119.0	+ 0.7	33,045	32,111	+ 2.9
South Louisiana	386.4	382.5	383.1	+ 0.9	107,322	101,889	+ 5.3
Michigan	44.1	42.0	47.9	— 7.9	12,044	12,482	— 3.5
Mississippi	101.5	100.0	128.5	— 21.0	28,859	33,808	— 14.6
Missouri	0.1	0.1	0.1	.....	34	39	— 12.8
Montana	24.7	24.7	26.6	— 7.1	6,985	6,971	+ 0.2
Nebraska	0.6	0.5	0.5	+ 20.0	176	173	+ 1.7
New Mexico	122.8	123.5	132.6	— 7.4	35,593	35,463	+ 0.4
New York	14.1	13.7	13.0	+ 8.5	3,349	3,481	— 3.8
Ohio	9.6	9.7	9.5	+ 1.1	2,573	2,471	+ 4.1
Oklahoma	389.9	378.2	429.1	— 9.1	111,616	113,582	— 1.7
Pennsylvania	29.1	29.0	34.9	— 16.6	8,504	9,554	— 11.0
Tennessee	.....	.....	.....	.....	6	6	.....
Texas	2,001.0	1,870.5	2,507.4	— 20.2	554,614	669,474	— 17.2
Dist. 1—South Central	27.2	25.9	28.8	— 5.6	7,213	7,452	— 3.2
Dist. 2—Middle Gulf	124.8	115.0	181.7	— 31.3	35,874	47,690	— 24.8
Dist. 3—Upper Gulf	386.5	355.1	507.0	— 23.8	108,155	135,819	— 20.4
Dist. 4—Lower Gulf-SW	191.7	181.1	253.0	— 24.2	53,808	69,449	— 22.5
Dist. 5—East Central	34.7	32.5	49.5	— 29.9	10,266	12,733	— 19.4
Dist. 6—Northeast	331.2	307.3	433.1	— 23.5	95,916	118,018	— 18.7
Dist. 7-B—N. Central	61.2	57.8	52.6	+ 16.3	16,396	12,843	+ 27.7
Dist. 7-C—West Central	49.9	42.8	44.9	+ 11.1	12,330	12,113	+ 1.8
Dist. 8—West	561.1	521.4	707.8	— 20.7	155,197	187,433	— 17.2
Dist. 9—North	140.1	137.5	140.0	+ 0.1	36,400	38,159	— 4.6
Dist. 10—Panhandle	92.6	94.1	86.8	+ 6.7	24,765	23,702	+ 4.5
Utah	2.2	1.8	.....	.....	225	.....	.....
Virginia	.....	0.1	.....	.....	30	26	+ 15.4
West Virginia	8.1	8.0	7.5	+ 8.0	2,080	2,005	+ 3.7
Wyoming	130.2	131.4	156.7	+ 16.9	34,763	40,252	— 13.6
Total United States	4,909.8	4,768.3	5,434.6	— 9.7	1,372,076	1,495,130	— 8.2







Completions

Fail to Equal 1948 Record

SEPTEMBER drilling held at about the same rate as in August, and as a result the year's total wells continued to shade those of last year. However, there had been a temporary slackening in well completions in September of last year, which was made up in the following month, and it is now a certainty that by the time October's wells are counted this year will have failed to equal 1948, the all-time record holder.

Completed wells totaled 3366 during September to show an increase of two wells over August's results, and to boost the year's total to 28,824. A year ago completions had amounted to 28,500, giving the current year's activity a lead of about one percent.

Footage drilled in this year's tests has amounted to 102,715,040 feet, which represents an increase of almost 6 percent over last year's 96,960,402. Increased drilling in the deeper areas and lessened activity in some of the comparatively shallow regions have jumped the well-depth average so far this year to 3598 feet, while the over-all average in 1948 was 3468, a difference of 130 feet for each test.

This year will go into the records with many firsts in the footage column. It will top all others in the over-all number of feet drilled and in the average depth of its wells. It has seen the first test ever to be drilled to 20,000 feet and the first well ever to produce oil from the 15,00-foot level.

The world's deepest well is a dry hole drilled to 20,521 feet in Wyoming by The Superior Oil Company earlier this year, and the deepest production is from a bottom of 15,530 feet in Standard Oil Company of California's recently completed West Coast test. Both of these drilling and producing marks appear fairly certain to stand for some time.

Well Completions in the United States During September, 1949, and Cumulative for Year

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from *The Producers Monthly.*)

STATE or DISTRICT	MONTHLY COMPLETIONS, SEPTEMBER, 1949									TOTAL COMPLETIONS				CUMULATIVE TOTAL				Rigs in Operation (Drilling, Rigging Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper											
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		Sept., 1949	Aug., 1949	Sept., 1948	Footage Sept., 1949	Wells 1949	Wells 1948	Percent Diff.	Footage 1949	Sept. 30, 1949	Aug. 31, 1949	Sept. 30, 1948
Alabama				1				1		1	1		3,400	12	13	— 7.7	61,341	3	3	5
Arizona														4	1	+300.0	11,496	4	5	7
Arkansas	11		1	19				31		31	31	26	126,192	242	234	+ 3.4	1,009,677	30	31	35
California	162		6	60				228	17	245	169	195	985,868	1,945	1,947	— 0.1	7,796,269	247	265	283
Colorado	1		1	2				4	1	5	10	10	18,201	50	169	— 70.4	218,704	19	17	45
Florida				1				1		1	2	1	7,560	13	20	— 35.0	84,838	4	4	4
Georgia														4	3	+ 33.3	12,437	1	1	
Illinois	122			127				249		249	245	218	538,081	1,890	1,743	+ 8.4	4,601,958	224	237	279
Indiana	46			64	1		1	112		112	115	112	219,884	894	775	+ 15.4	1,676,695	142	139	126
Kansas	129		50	94			3	276		276	279	217	885,190	2,227	2,201	+ 1.2	7,382,672	291	280	333
Kentucky	35		23	28				86		86	88	64	170,266	681	580	+ 17.4	1,246,188	94	93	78
Louisiana	156	19	29	45			1	250		250	241	190	1,214,972	1,703	1,631	+ 4.4	9,274,150	220	196	209
North Louisiana	112	9	28	28			1	178		178	180	146	592,302	1,019	1,068	— 4.6	3,326,019	78	60	66
South Louisiana	44	10	1	17				72		72	61	44	622,670	684	563	+ 23.7	5,948,131	142	136	143
Maryland															1	—100.0				
Michigan	53		8	59				120		120	60	56	283,793	699	525	+ 33.1	1,588,248	123	136	125
Mississippi	13	3		10				26		26	30	29	180,561	254	306	— 17.0	1,858,099	29	33	33
Missouri				1				1		1	2	1	810	15	39	— 61.5	7,812	6	5	8
Montana	14		1	11				26		26	27	25	56,617	194	223	— 13.0	489,812	47	52	61
Nebraska	1			1				2		2	2		9,154	7	1	+600.0	28,370	3	3	
Nevada																				1
New Mexico	26		6	14				46		46	45	32	197,000	392	448	— 12.5	1,698,303	91	91	120
New York	24				17			41		41	76	170	57,949	708	1,367	— 48.2	999,214	86	103	213
North Dakota				2				2		2			8,208	2			8,208	2	3	
Ohio	24		22	26				72	1	73	112	135	143,613	780	995	— 10.8	1,671,596	162	164	206
Oklahoma	228	2	22	126	1		2	381	11	392	417	320	1,346,072	3,224	3,049	+ 5.7	11,472,595	509	499	553
Pennsylvania	48		28	12	40	10		138		138	188	312	246,226	1,537	2,492	— 38.3	2,755,073	248	264	435
South Dakota														2	1	+100.0	6,905	2	3	1
Tennessee											4	2		18	34	— 47.1	23,489	6	6	14
Texas	713	14	72	322	3			1,124	16	1,140	1,124	900	4,706,427	10,482	8,703	+ 20.4	43,400,558	1,314	1,150	1,394
Dist. 1—South Central	13		1	26				40		40	50	47	134,480	425	359	+ 18.4	1,280,212	37	34	38
Dist. 2—Middle Gulf	28	1	6	20				55	1	56	54	48	318,954	499	554	— 9.9	2,917,000	48	50	63
Dist. 3—Upper Gulf	68	9	7	29				113		113	116	73	636,541	1,012	784	+ 29.1	6,081,021	120	110	137
Dist. 4—Lower Gulf-SW	63	2	4	35				104	2	106	87	100	550,145	1,026	1,016	+ 1.0	5,120,585	94	98	119
Dist. 5—East Central	8	1		5				14		14	9	13	72,261	155	158	— 1.9	732,185	21	15	19
Dist. 6—Northeast	56	1	4	10				71		71	74	33	314,131	690	287	+140.4	3,016,493	36	41	43
Dist. 7-B—N. Central	57		6	88				151		151	154	107	419,432	1,442	1,030	+ 40.0	4,259,690	196	160	212
Dist. 7-C—West Central	29			10				39	1	40	41	37	173,234	341	306	+ 11.4	1,577,066	87	82	61
Dist. 8—West	203		4	20				227	9	236	251	235	1,183,425	2,138	2,161	— 1.1	10,495,508	378	324	430
Dist. 9—North	133		2	75	3			213	3	216	230	154	585,689	1,947	1,639	+ 18.8	5,298,195	176	140	122
Dist.10—Panhandle	55		38	4				97		97	58	53	318,135	807	409	+ 97.3	2,622,603	121	96	151
Utah	3			5				8	1	9	6	1	50,517	46	16	+187.5	225,524	10	14	10
Virginia															1	—100.0				
Washington															2	—100.0				
West Virginia	9		29	6				44		44	40	72	134,858	352	601	— 41.4	1,024,185	246	231	302
Wyoming	24		1	24				49	1	50	50	40	225,275	447	379	+ 17.9	2,080,624	80	90	141
Total United States	1,842	38	299	1,060	62	10	7	3,318	48	3,366	3,364	3,128	11,816,694	28,824	28,500	+ 1.1	102,715,040	4,243	4,118	5,116

Looking Ahead

BUSINESS OUTLOOK for 1950 now is widely considered good, assuming reasonably early settlement of strikes and no resultant price increases that would retard sales. Favorable factors cited include high consumer income and demand for goods and services, low money rates, government spending, veterans' insurance dividends. Unfavorable factors that exist, however, include declining capital expenditures by industry, lower exports, potential oversupply of goods, surplus commodities, price uncertainties.

DEMAND FOR PETROLEUM PRODUCTS will be affected adversely for fourth quarter of year by steel strike. Gasoline consumption will be reduced through idleness of heavy, steel-carrying trucks and less use of automobiles by many steel workers. Also, steel industry is large consumer of fuel oil, having used 143,000 barrels daily average in 1948.

ANOTHER WAR probably would require every barrel of petroleum that Western Hemisphere could produce, and to assure self-sufficiency of hemisphere, its oil industry must be healthy and vigorous, stated Lt. Gen. LeRoy Lutes of Fourth Army, former director of Munitions Board staff, to Texas Mid-Continent Oil & Gas Association. He suggested some U. S. use of Eastern Hemisphere oil to avoid unlimited depletion of domestic resources but said imports should be reasonable and not prevent active domestic development.

KANSAS SUPREME COURT and eventually U. S. Supreme Court likely will decide whether Kansas Corporation Commission exceeded power in fixing minimum wellhead price of natural gas in Hugoton field, although district court has upheld commission. Three gas purchasing companies contended commission exceeded authority and denied them constitutional rights. Commission conceded it had no price-fixing powers as such but contended its fixing of minimum price was "a conservation order," to conserve gas for efficient use.

EAST TEXAS FIELD ultimately will produce 5 billion barrels, with benefit of restricted flow and re-injection of salt water, said Lt. Gen. Ernest O. Thompson of Texas Railroad Commission. Without regulation, only 1 billion originally was expected. This water-drive field is 19 years old and already has produced 2.6 billion barrels. Re-injection of salt water is increasing primary recovery through flowing production by maintaining reservoir pressure and at the same time is form of secondary recovery by flushing oil through sand to wells.

SHARP INCREASE in demand for lubricants for automobile automatic transmissions is expected in next few years, as new cars go largely to use of this type transmission. Oil companies will soon find this lubricant market comparable in gallonage with that for permanent type anti-freeze. This special lubricant is also a power and heat transfer medium and a hydraulic control fluid.

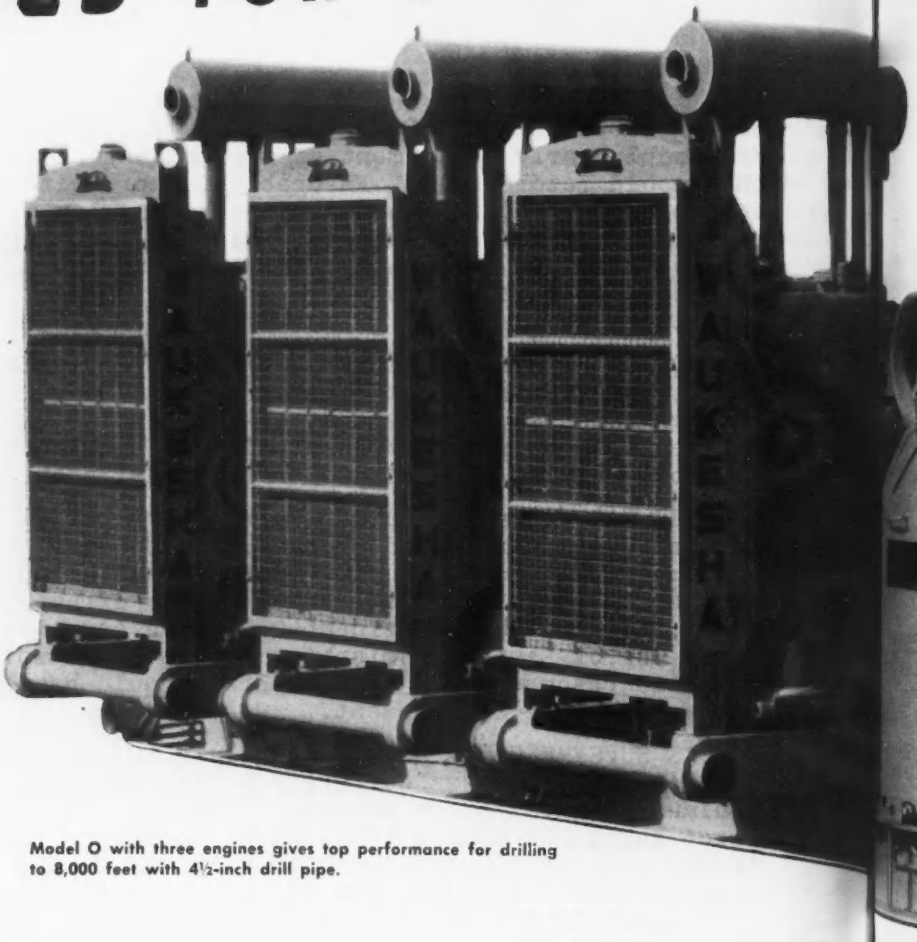
AT LEAST $30 MILLION will be spent for refinery expansion in Western Canada in next two years to utilize new crude sources in Alberta. Prairie refinery capacity thereby will be increased to more than 80,000 barrels daily by end of 1951. Besides work planned for Edmonton, Alberta, plant construction is planned or contemplated for Saskatoon, Moose Jaw, and Regina in Saskatchewan and for Brandon and Winnipeg in Manitoba.

THE WELL PROVED "CARDWELL"

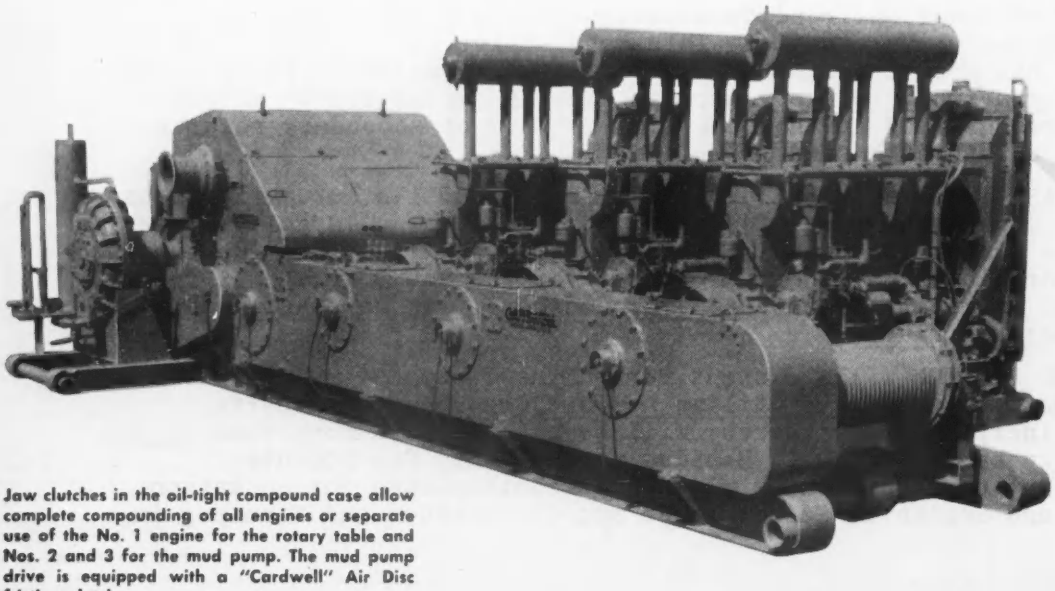
IS NOW AVAILABLE WITH

3 ENGINES FOR GREATER

BIG, rugged, powerful—that's the Model O draw works with three engines. It answers the need for a high performance, deep well drilling rig that is easy to operate and inexpensive to maintain. With three engines developing 600 H. P., adequate mud pump power and faster hoisting speeds are always at the driller's fingertips.



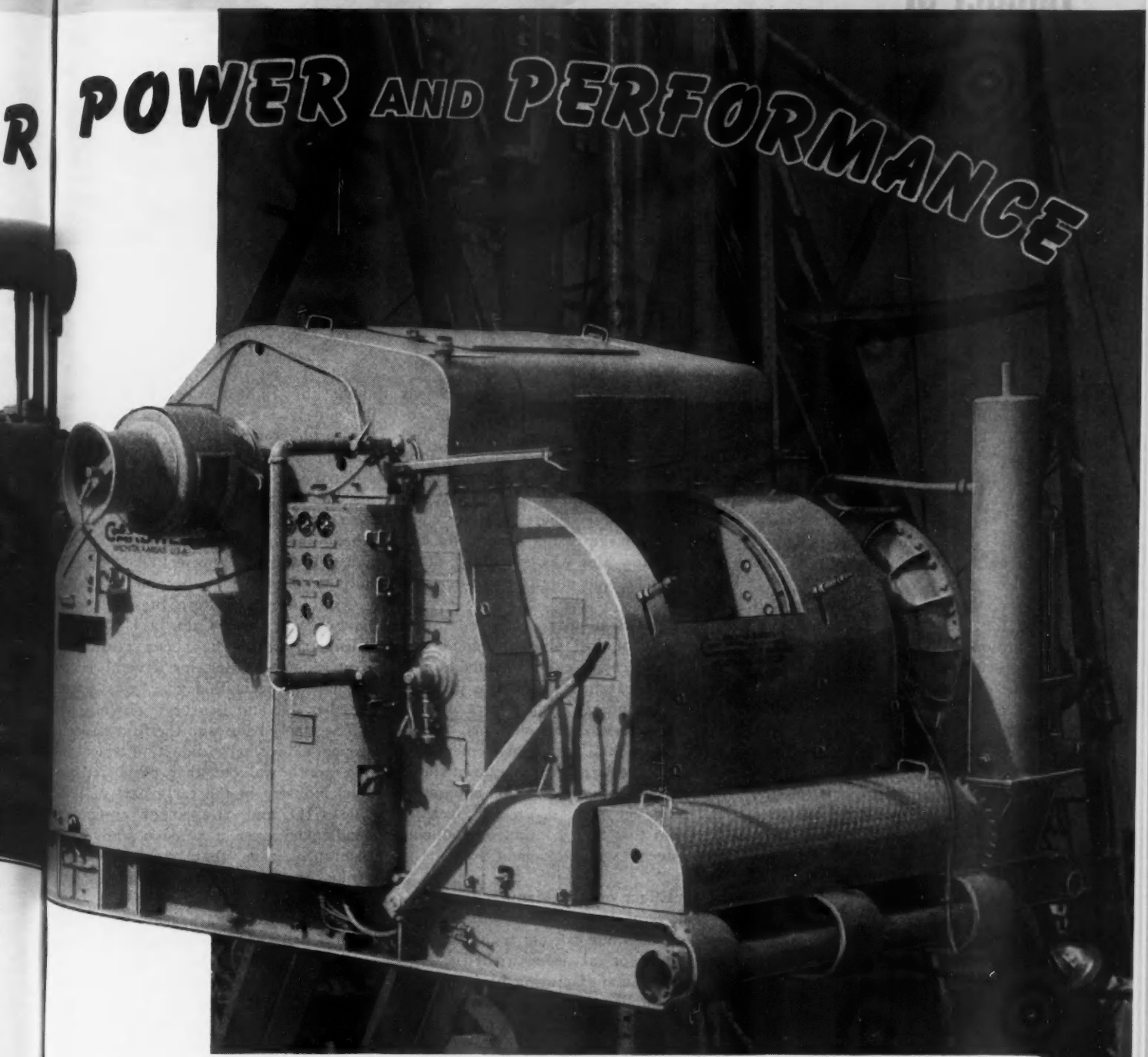
Model O with three engines gives top performance for drilling to 8,000 feet with 4½-inch drill pipe.



Jaw clutches in the oil-tight compound case allow complete compounding of all engines or separate use of the No. 1 engine for the rotary table and Nos. 2 and 3 for the mud pump. The mud pump drive is equipped with a "Cardwell" Air Disc friction clutch.

MODEL O DRAW WORKS...

POWER AND PERFORMANCE



The Model O is completely air controlled. "Cardwell" Air Disc friction clutches, used in both ends of the main drum, provide two instantly available speeds for each of the three transmission ratios. Model O is also available with manually-controlled friction clutches. The draw works and three engines are mounted on a heavy, three-rail main skid and when necessary, the engines can be easily removed for transporting. Sand line drum assembly and hydromatic brake are available.

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Impact of Steel Strike Has Varied Effect

By J. E. KASTROP
Gulf Coast District Editor

THE deadlocked steel strike, almost a month old in late October, had not yet shown any detrimental effect upon the industry at large. Some independent operators were having difficulty in getting oil well casing, but many of these cases had been eased by purchases from the larger oil companies that managed to build up casing inventories since the war ended.

Major companies appeared to be well situated for the strike and could survive a prolonged one if necessary without appreciably curtailing operations. Pipe line companies with construction projects under way would suffer if line pipe was not available in 30 days. Some major projects had already bogged down due to pipe shortage. Large cross-country and vast looping projects of the pipe line companies would be curtailed by the steel shortage unless the strike ended shortly.

Items hardest hit by the steel strike were oil well casing and line pipe. Since the war, large integrated oil companies have built up inventories of casing to a level beyond their immediate requirements. Last month they actually sold large amounts of this excess casing. When the strike started, these offers were, of course, immediately withdrawn. The small operator, not able to carry large inventories of casing, felt the impact of the strike almost immediately. Pipe supply companies were of considerable help to these independents by contacting the larger companies with ample casing stocks to fill the requirements of the small operator. There has been in the past several weeks much of this pipe buying between small and large companies and even between a few of the bigger operators. Some companies purchased casing on the "gray market," paying higher prices than regular list price.

To even the middle-sized oil company that manages to plan drilling programs a few months in advance, and purchases pipe by the quarter, the outlook for receiving pipe deliveries in November and December was not encouraging. Pipe manufacturers, for the most part, continued to take orders for casing, and tried to get these orders filled by companies with large casing inventories, but as far as new pipe was concerned, nothing could be said about future delivery dates.

Suppliers of tubular goods stated that the supply of drill pipe was good, and any order received could be filled almost immediately from stock. Major items of drilling equipment, such as drawworks, engines, rotaries, transmissions, travelling blocks, etc., were not immediately affected. One large manufacturer stated that their plants making this equipment had not yet shut down for lack of steel, but that they continued producing from steel reserves on hand.

Effect on Bit Manufacture

Makers of drilling bits reported ample steel to continue normal manufacturing schedules for at least another two months. A manufacturing plant for one major supplier was shut down immediately when the strike began, and the fabrication of pumping units and hoists was thereby discontinued. Some orders for this equipment could be filled from stock, it was reported, but additional orders cannot be filled until four months after the plant resumes operation. Other companies reported ample equipment on hand to satisfy their sales for several months. The supply of sucker rods and pumps appeared to be satisfactory.

The tremendous pipe line construction program for the remainder of this year will be practically shut down unless pipe is again available within the next 30 days. Sufficient pipe is available on one large pipe line project to last for the remainder of this year. This pipe has been either strung or stored along the right-of-way. If additional line pipe is not available by Christmas, this project will also be curtailed. On another major project, Pacific Gas and Electric Company's 34-inch, 605-mile gas line from San Francisco to Topock, Ariz., about 50 miles had been laid when line pipe supplies became exhausted and the project discontinued until additional pipe became available.

Consolidated Western Steel Corporation of Maywood, Calif., a U. S. Steel subsidiary which has been fabricating large diameter pipe for several major gas line projects this year, was struck October 13, and has been down since.

The steel strike was the first national stoppage in steel production since the one-month walkout that paralyzed the steel industry in the early part of 1946. The CIO and the steel companies deadlocked over a pension and social insurance issue that precipitated the strike. In a fourth-round fight for pay increase, the CIO asked for 12½ cents per hour raise, plus pension and insurance benefits that would bring the total company-paid "package" to 30 cents per hour increase. President Truman appointed a Fact-Finding Board which recommended that the steel companies put up 6 cents an hour for pensions and 4 cents an hour for social insurance. The industry offered to post the 10 cents for these two items provided the workers put up an additional contribution of their own, but the union refused. A few small steel companies, representing less than 5 percent of the nation's normal steel output, agreed to the terms of the Fact-Finding Board. U. S. Steel and others demurred.

Directly affected by the strike were 500,000 steel workers whose aggregate pay loss amounts to an estimated $58 million weekly. Unless the strike ended shortly, an additional 500,000 men in fabricating plants all over the country would be let out due to lack of steel.

# of Pipe Line Contractors

By E. G. MORRISON

Morrison Construction Company, Inc., Austin, Texas

AS SOON as the operations of the pipe line contractor go across the lines of his home state, legal complexities begin to increase. This is true whether the contractor operates as a sole proprietorship, partnership or corporation; however, the problems are even more acute for the contractor who has incorporated his business.

There has been a rapidly growing body of state and federal regulations affecting the pipe line contractor. Many of the requirements are recent and the list of them is ever expanding. Unless the contractor is fully aware of the requirements made by the various states in which he expects to do work, he may find himself in what seems an endless morass of red tape, delays and unexpected costs.

The various taxes and fees which are required vary greatly from one state to another. A successful contractor cannot afford to overlook these items of overhead expense. Often the liability of the contractor for such taxes is not asserted until long after the job is completed, but the liability to pay is nonetheless present. Failure to pay the taxes or fees when due may and often does result in severe penalties in the form of additional taxes not included in the original cost estimate. Advance knowledge of the various regulations is important, as the burden of filing tax returns and obtaining licenses is usually placed upon the contractor and not the local taxing and licensing authorities. Ignorance of the contractor as to the regulations is no excuse, and the contractor who is not familiar with the regulations may well be presented with a tax bill he did not expect and to which has been added penalties because of his failure to file a return as the law required. Even more costly is the possibility that a contractor who has failed to obtain a required license may be suddenly forced by local authorities to shut down operations, pending the obtaining of a license. Time is an important factor in the pipe line business, and no contractor can afford to lose time because of lack of knowledge of the state requirements.

Most of the governmental regulations affecting pipe line contractors are applicable to other types of contractors as well. These regulations have been enacted to accomplish one or more of three broad purposes: the first, and most important, is to raise revenue; the second is to protect the public, including laborers and customers, from contractors who are lacking in know-how, experience, and financial responsibility; and the third is to protect the interests of local contractors and local business in general.

Taxes and Requirements

The following list of types of taxes and requirements is not necessarily all-inclusive but is typical of what a pipe line contractor may encounter.

1. Federal Income taxes, Social Security taxes and Unemployment Compensation taxes. These of course affect nearly all types of business wherever located.

2. State Income taxes in some states.

3. Gasoline and Fuel taxes. In many states a total or partial refund may be obtained as to taxes paid on fuel used other than on the state highways.

4. Power tax. This tax is based on the horsepower of the machinery used in the state and applies whether the machine operated in the state for one day or the entire year.

5. Fee for a corporation to obtain a permit to do business in a state other than that in which it is incorporated. The amount may be a uniform fee or may vary with the amount of capital of the corporation. Failure to obtain such a permit usually subjects the corporation to the danger of an injunction as well as penalties. The corporation operating in a state without a permit is often denied access to the state or federal courts. No corporation can afford to run this risk.

6. Use tax. This tax is usually a percentage of the cost of equipment or materials imported into the taxing state from some other state. Frequently, credit is given to the taxpayer if a sales tax has been paid elsewhere on the same equipment or materials.

7. Occupational tax. This tax may depend on the size of the contractor or on the type of work conducted.

8. Gross Receipts tax. This exists in a few states only and is a percentage of money received for contracts performed within the state.

9. Franchise tax. This is an annual tax on a corporation's privilege of doing business within a state.

10. Ad valorem property taxes on personal property.

11. Contractors License Fee. Many states require a license before a contractor can work in a particular state. Frequently the requirement is operative only if the value of the contract exceeds a certain minimum. Pipe line contracts usually exceed the minimum. In other states a contractor is required to obtain the license before bidding on a contract exceeding a certain minimum amount. In some states examinations are required, and in others only a fee is required. Difficulty can be encountered where the contractor must appear before an Examining Board which meets only at rare intervals. It may be necessary to obtain a special meeting of the Licensing Board in order to qualify in time to bid or perform the contract work without violating the law.

In at least one state it is necessary for contractors operating as joint ventures to obtain a new license even though each of the joint ventures is already licensed.

Of course, the contractor must comply with the motor vehicle registration

■ CONTINUED ON PAGE 44

Ickes and Pearson

and the Truth

HAROLD ICKES and Drew Pearson cannot possibly misunderstand the issues involved in the controversy over the ownership of submerged coastal lands so completely as their continued misrepresentations would indicate. Their misrepresentations are too flagrantly opposite to the facts to be honest or innocent. They are palpably deliberate and their only possible object is to deceive the public. No other explanation is tenable. And the end to which their attempts to deceive the public are directed is that of creating prejudiced public sentiment calculated to affect the ultimate action of Congress.

A comparison of their principal misrepresentations with the facts is sufficient to show this conclusively.

Both of them picture the controversy as being between the federal government and the "big" oil companies, whereas it is between the federal government and the states, especially Texas, Louisiana, and California. Mr. Ickes says that "the oil companies" continue "improperly to appropriate to their own profit oil that belongs to the people—that is if the Supreme Court is to be credited." And Mr. Pearson habitually refers to those who oppose the federal government's claims as "the oil lobby." The fact is that the oil companies that are producing petroleum from submerged coastal lands are not appropriating any oil that would go to the federal government if all of its claims were established by Congress. They pay the usual landowner's royalties, and the question at issue is whether those royalties should go to the federal government or to the states. In the case of Texas the question is whether the royalties should be handed over to federal bureaucrats or be paid to the school fund for the benefit of the present and future generations of Texas school children.

As for "profit," the expenditures of the oil companies for initial exploration and for drilling in the soil of the sea under unprecedented conditions are so enormous that it is far too early to speak of "profit" in connection with these operations. Meantime, the oil companies are concerned to have valid titles to their leases of submerged lands and they want to see the question of ownership settled once and for all.

MISREPRESENTATIONS of the Tidelands question have been made deliberately by Harold Ickes and Drew Pearson to create prejudiced public sentiment to influence the action of Congress. By ignoring the facts—but not through ignorance of the facts—both have contributed to the confusion surrounding the issue, and to the consequent delay in settlement. This article is published by permission of *The Southern Weekly*, Dallas, in which it first appeared September 28, 1949.

Both Mr. Ickes and Mr. Pearson continually make the statement that the Supreme Court has decided that the federal government owns the submerged coastal lands. This is not true. In the first place the decision of the Supreme Court applies only to California, and it does not hold that the federal government "owns" the lands under the coastal waters of that state. It holds merely that the federal government has "paramount rights in" and "power and dominion over" those lands. It has yet to decide the cases of Texas and Louisiana. Even if the court should decide against these two states, it would still be up to Congress to determine how and to what extent those "paramount rights" and "power and dominion" shall be exercised.

Glaring Error

But the most glaring misrepresentation these two gentlemen are continuously making is their habit of giving the impression that the decision of the Supreme Court in the California case applies to the entire continental shelf, and not merely to the three-mile belt. Most of the good oil lands in the Gulf of Mexico are outside the three-mile belt, and even outside the three-league belt of the Texas coast. Yet Mr. Ickes and Mr. Pearson always speak as if the decision of the Court applies to all these lands.

The Supreme Court's decision in the California case is based entirely on the circumstance that the federal government in 1793 established the three-mile belt. The "paramount rights in" and "power and dominion over" that belt, which the Court says the federal government possesses, were acquired at that time and by that act, according to the Court's own reasoning. This is the only claim that the federal government may be said to have to any part of the continental shelf, and this claim is confined strictly to the three-mile belt. The ground on which the Court reached its decision cannot possibly be stretched into giving the federal government even the semblance of a claim to the rest of the continental shelf.

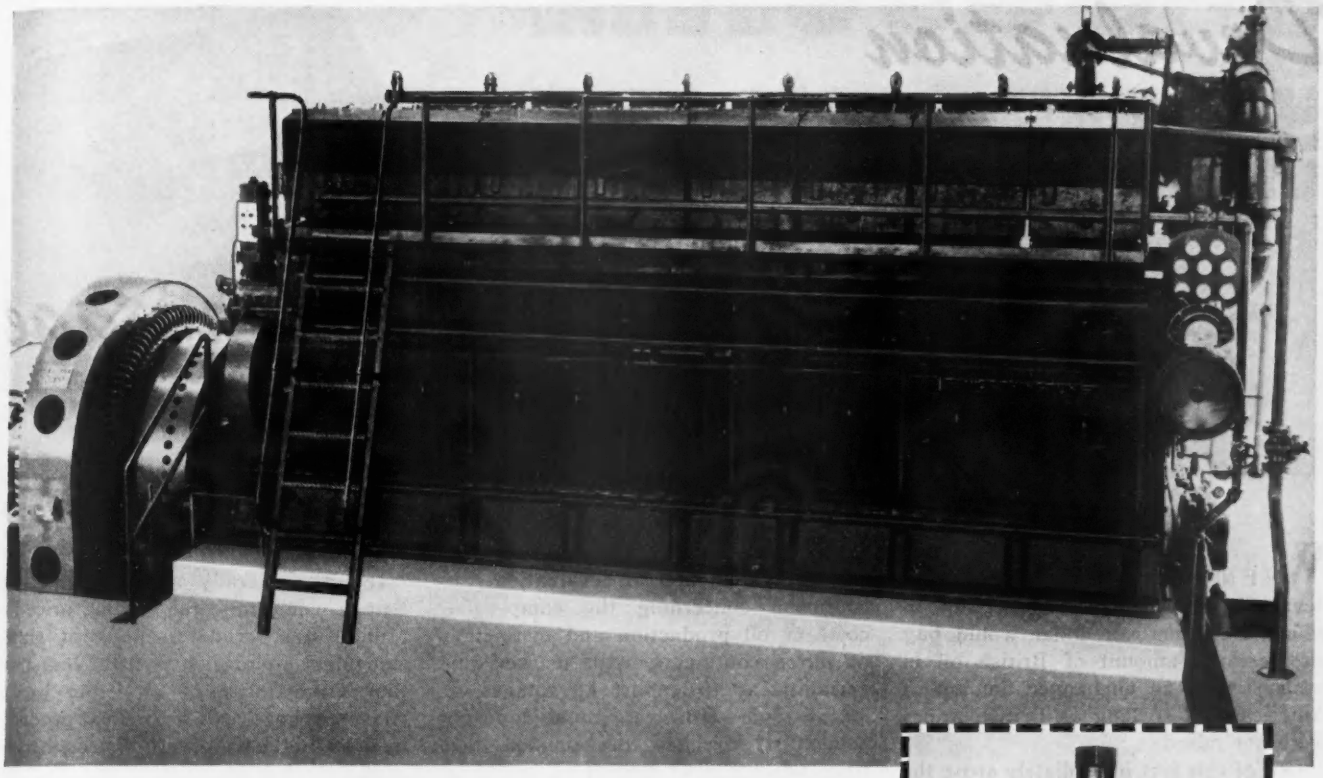
It should be noted also, that the Court's decision is based on the assumption that the original states did not have jurisdiction over their coastal waters during the ten years between 1783, when the Treaty of Paris with England was signed, and 1793, when the three-mile belt was established by the federal government. This, we think, is an extraordinary and unwarranted assumption, but the Court acted on it, nevertheless. It remains to be seen how the Court will dispose of the undoubted fact that Texas exercised jurisdiction over its coastal waters for nine years prior to its annexation to the U. S., to say nothing of the exercise of jurisdiction over those waters by Mexico and by Spain long prior to the establishment of the three-mile belt by the federal government of the U. S.

But it cannot be too strongly stressed that the Supreme Court's decision applies only to the three-mile belt and that any claims of the federal government based on that decision are confined strictly to the three-mile belt. No claim to the rest of the continental shelf (which means the greater part of it) can be based on that decision.

On September 28th, 1945, President Truman issued a proclamation and an executive order pertaining to the continental shelf. The proclamation was an announcement to the nations of the

■ CONTINUED ON PAGE 44

Another reason for the superiority of Worthington Dual Fuel Engines . . .



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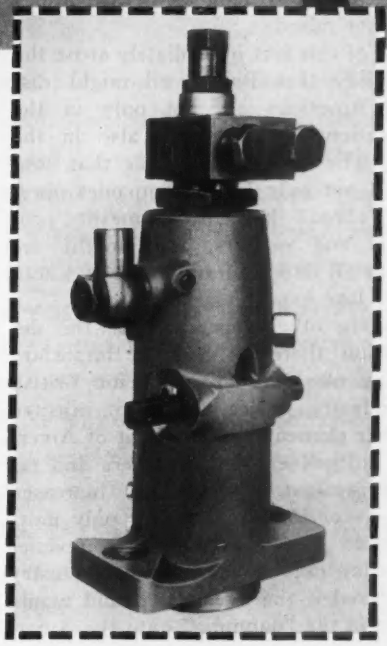

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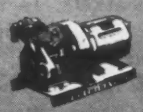

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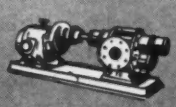

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Devaluation May Give British Oil Only Temporary Advantage

By HENRY OZANNE
Eastern District Editor

WHEN the British pound was devalued, a situation was set up in which the American dollar would buy an increased amount of British oil in contrast with an unchanged amount of American oil, so long as British prices were not raised.

Out of this fact immediately arose the possibility that British oil might displace American oil, not only in the international markets but also in the U. S. The situation was one that concerned not only U. S. companies operating abroad but also domestic producers and refiners, who might see British oil imported and some of whom might lose export markets.

Among other repercussions, the devaluation therefore had an important bearing on ECA financing for British oil industry projects. Also, it injected another element into the fight of American independent oil producers and refiners against sustained or increased imports of foreign oils. Not only independents but also larger companies operating only in the domestic industry wondered if the devalued pound would result in the "dumping" onto the American markets of large quantities of cheap oils and refined products produced by British interests in South America and the Middle East. In their scramble for dollars, would the British increase oil output in some of the world's major oil producing areas and sell the "devalued" product in competition with American oil?

It is generally conceded that in itself sterling devaluation could result in a price-wise competitive advantage for British oil. However, there are several important economic, political, and other reasons to expect sterling prices to be adjusted upward eventually to an extent that will nearly equalize the price structures of the British and American oil industries.

The first reaction to devaluation was confusion concerning the competitive costs of oil production and distinction on three continents, with marked uncertainty as to export advantages of sterling oil. However, most industry economists reached the opinion that price advantage of British oil would be only temporary and largely wiped out eventually.

Dollar Costs

The most important factor pointing to this conclusion is the fact that dollar costs of British interests are very substantial in many producing areas, notably Venezuela and the Middle East. This fact alone should prevent the British industry from permanently undercutting American prices very greatly. While British manufacturers make and sell oil industry equipment, they supply only a relatively small part of the world market for this equipment. British oil companies buy heavily from American manufacturers of equipment and must continue to pay in dollars. This charge against operations will act as a direct deterrent against oil price cuts on world markets.

The British government evidently foresaw that there would be strong pressure for prompt raising of British oil prices. The British Ministry of Fuel and Power quickly requested British oil companies to delay price increases until London could have time to study the oil problem. Therefore, the devaluation of the pound by 30.5 percent probably will have only a temporary effect in lowering sterling oil prices by that amount in international oil markets. In fact, even though oil prices inside Britain continued unchanged for the moment, sterling prices of fuel oil and bunker diesels for sterling areas outside Britain were scheduled to be increased about 40 percent November 1.

It was generally expected that the British would raise the sterling price for Middle East crude to make it either equivalent to or just a little less than the current price of $1.75 per barrel. Also, sterling prices for refined products in the Middle East were expected to be increased by the British to the full extent of the devaluation.

British action ultimately hinges on what is done by Anglo-Iranian Oil Company in the Middle East and by the Shell Group in Venezuela. In both of these instances, action probably will be influenced by political and diplomatic considerations as well as economic factors, all of which will be weighted on the side of the avoidance of underselling American oil. The British government, which controls a large share of Middle East crude through its 52 percent stock ownership of Anglo-Iranian, is unlikely to further antagonize the strong element in the U. S. which seeks to restrict ECA expenditures in Great Britain and Europe. This element in American politics has long criticized the policy of financing Britain's experiments in Socialist government and points out that the British are in their present precarious financial situation because of their political philosophy, which is contrary to the American principles of free enterprise. Similarly, Shell Group interests in the U. S. are too important to jeopardize by a price policy that would go contrary to American sentiment.

Aside from the fact that the British are not in position to undersell American oil materially because of their high dollar costs, there are other important economic reasons for equalizing British with American prices. Petroleum is one of the United Kingdom's largest sources of foreign exchange income, and efforts to maintain or increase these revenues may require the raising of sterling prices of oil at least nearly to the extent of

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devaluation. Although the principal source of crude oil for Europe is the Middle East, refined products move in large volume from the Western Hemisphere to Western European markets, and therefore, refined product prices in Europe are based principally on the dollar market of the U. S. Gulf Coast. A price war at this time consequently might injure rather than help the British economy. In these circumstances, British refiners of the Middle East are expected to equalize their delivered prices in Western Europe to the delivered price from the Western Hemisphere. This means that the sterling price must be increased to the full extent of devaluation.

Middle East Oil

Another factor should operate for a sterling-dollar parity in so far as Middle East oil is concerned. In the Middle East, royalty on British oil production is payable in gold, and now that the pound has been devalued, it takes more sterling to buy the gold. Furthermore, the Iranian government has been demanding a higher royalty. Also, the British government converts to gold a sizable portion of Iran's sterling income, and it is probable that the Iranian government will demand the same amount in dollars as it has been receiving.

Due to devaluation of the Canadian dollar to 90 cents, there has been already a general upward adjustment in both crude and product prices in Canada. Leduc crude was advanced 25 cents a barrel to $3.20; Redwater and Turner Valley crudes were raised 20 cents a barrel to $2.88 and $3.44 respectively for 33 gravity oil. In Eastern Canada retail gasoline prices jumped 1.5 cents a gallon and light fuel oil 1 cent.

British oil companies have been enjoying a substantial advantage over American companies in many world markets because of selling oil for sterling, which American firms could not do, due to difficulties of converting sterling into dollars. Hence British petroleum expansion in international oil markets has been limited mainly by production rates and refining capacities, while American companies have been forced to restrict their trade in many areas.

Aside from the question of world oil prices, devaluation and attendant British exchange controls could have a long range competitive effect favoring British oil development in many producing areas. At present there is a heavy dollar cost as well as sterling cost in British oil production. To increase the amount of sterling oil available it is reported that Britain may demand a slice of now wholly held American oil concessions in the Middle East, such as the Saudi Arabia concession. Such a move, if successful, would have the effect of slowing American producing operations in the Middle East for the benefit of the British. American companies cannot sell oil for sterling today, because of the problem of convertibility, and it is conceded that some measure of convertibility is essential if the British petroleum industry does not continue to displace dollar oil in an increasing number of world markets.

This question of convertibility—the ability of American businesses to turn at least a part of their sterling earnings into dollars—is reportedly the most crucial issue before the American-British-Canadian oil conference which began in Washington late in September. Devaluation was announced three days after the conference first met and the entire British delegation said it had been caught in such surprise that it asked deferment of the oil talks until the result of devaluation could be known. On word from London, however, the conversations were resumed. The conference announced that it would "analyze oil transactions affecting the sterling area in the light of the legitimate interest of the countries and the companies concerned." The basic fact confronting the oil experts was the $400 million a year expenditures that the sterling area is now making for oil from dollar sources.

After two weeks of conference there was no indication that the delegates were finding any way to solve the problem of how British oil companies can enhance their position in the world market without further damage to the American oil industry at home and abroad.

American Opinion

There is increasing consensus in the American petroleum industry that before this government makes available further funds for the expansion of British oil producing and refining facilities around the world, (1) greater use should be made of existing American petroleum facilities, (2) American oil companies should be allowed to sell for sterling. The chief impediment to British plans for maximizing their share in the international oil market is lack of refining capacity. To expand this capacity, huge amounts of refinery equipment must be bought in the U. S. and paid for in dollars. The British are seeking those dollars from ECA and hope to have what they consider adequate plant capacity by 1953. The A-B-C oil talks, after their first two weeks, gave little indication that a policy would be forthcoming to prevent the realization of the British program.

Ickes, Pearson and Truth

■ CONTINUED FROM PAGE 40

world that "the government of the United States regards the natural resources of the subsoil and sea bed of the continental shelf beneath the high seas but contiguous to the coasts of the United States as appertaining to the United States, subject to its jurisdiction and control." But the executive order provided as follows: "Neither this Order nor the aforesaid proclamation shall be deemed to affect the determination by legislation or judicial decree of any issues between the United States and the several states, relating to the ownership or control of the subsoil and sea bed of the continental shelf *within or outside of the three-mile limit.*"

These are facts, and they completely refute the misrepresentations which Mr. Ickes in his column in *New Republic* and elsewhere and Mr. Pearson in his radio broadcasts and his widely printed newspaper column are industriously propagating. Unfortunately these facts are not widely understood among the American people. In consequence prejudiced public sentiment against the claims of the states is being created which must be overcome if Congress is to act wisely and justly in this matter.

Legal Problems of Pipe Line Contractors

■ CONTINUED FROM PAGE 39

and licensing statutes in the various states. The contractor may not haul for others without complying with the state laws applicable to common carriers. Before work is commenced in a new state, the maximum load limit laws should be consulted to determine whether the loads anticipated will exceed the allowable limit.

Workmen's Compensation statutes differ widely in their effect on the pipe line contractor. In some states State Fund insurance is compulsory. Care should be taken to assure that policies of workmen's compensation insurance contain endorsements for all states in which operations are to be carried on. If this is not done, the contractor may be liable for penalties and may be stripped of defenses in the event of a suit by an injured workman not covered by insurance.

In this summary of taxes and regulations, emphasis has been placed on regulations of the state governments. It must be remembered, however, that many county and municipal governments have the power to exact occupational and other taxes and to make safety regulations. It is not unusual to find such taxes levied by cities or counties, even though the state may have similar taxes in effect at the same time.

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2083

Better *Demand* Indicated

By L. J. LOGAN
Associate Editor

TOTAL demand for all oils has shown some improvement in recent months, although it still is falling short of some of the more optimistic expectations. Daily average total demand was 3.0 percent less in the first half of 1949 than in the like period of 1948. In July it was down 3.8 percent from that month last year, but in August it was off only 1.3 percent and in September it was up 0.7 percent, indicating for the first nine months of this year a decrease of 2.6 percent.

Holding down the total demand lately has been the unfavorable trend of exports. Whereas exports were nearly the same this year as they were last year for the first six months, they have been down materially after dropping sharply in June and July. Total exports in July were 37 percent below last year. For this year's first nine months the daily average is down about 10 percent.

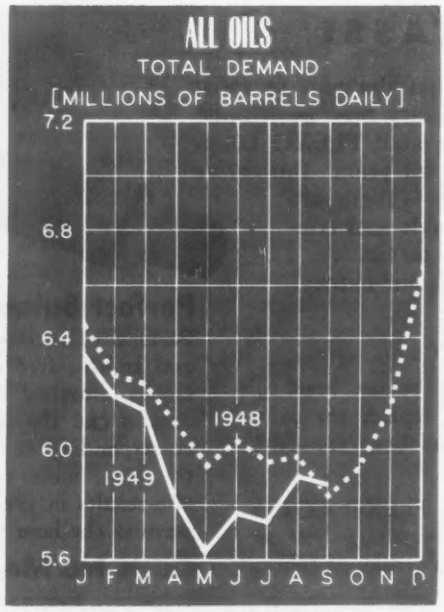
Total domestic demand for petroleum products was 3.2 percent less than last year for the first half of 1949, on a daily average basis. It remained 1.1 percent under last year in July, but went about 0.3 percent above last year in August and about 1.8 percent above 1948 in September, preliminary figures indicate. Thus for the first nine months the decrease from last year was cut to about 2.1 percent.

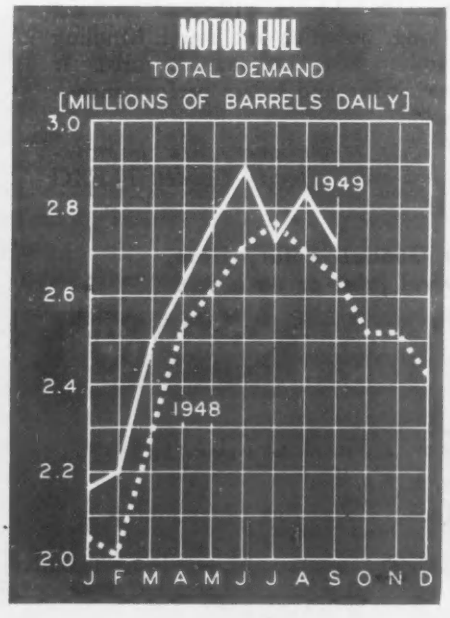
The total demand for motor fuel has been affected adversely in recent months by lower exports but still showed a gain of 5.1 percent over last year for the first nine months, as exports had been relatively heavy earlier in the year. Domestic demand for motor fuel also has shown some unfavorable signs. For the first six months of 1949 it showed an increase of 5.7 percent on daily average basis and then showed gains of 1.0 percent in July and about 5.9 and 3.1 percent in August and September, indicating for the first nine months of 1949 an increase of 4.8 percent over last year.

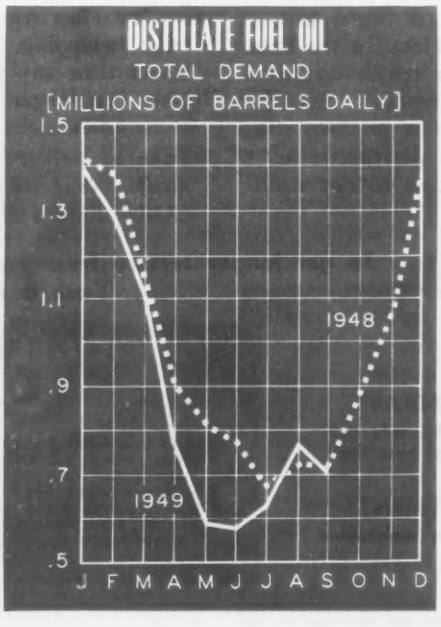
Daily average total demand for distillate fuel oil was 11.1 percent under last year for the first six months of 1949 but showed a decrease of 6.3 percent in July, a 6.1 percent increase for August, and a 2.2 percent decrease for September, indicating for the first nine months a daily average about 8.5 percent under last year. Exports have been off sharply. Domestic demand was 9.5 percent under last year for the first six months, up 2.7 percent for July over that month last year, up 13.3 percent in August, and up 0.4 percent in September, making the decrease from last year 6.0 percent for the first nine months.

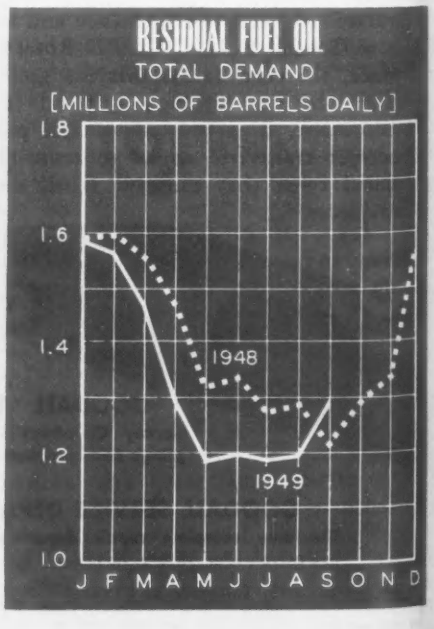
The daily average domestic demand for residual fuel oil was 7.2 percent under last year for this year's first six months, down 6.7 percent for July, down 7.1 percent for August, but up 7.0 percent for September, indicating decrease of 5.8 percent from last year for the first nine months.

■ SEE TABLE ON PAGE 48









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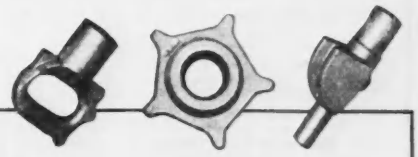

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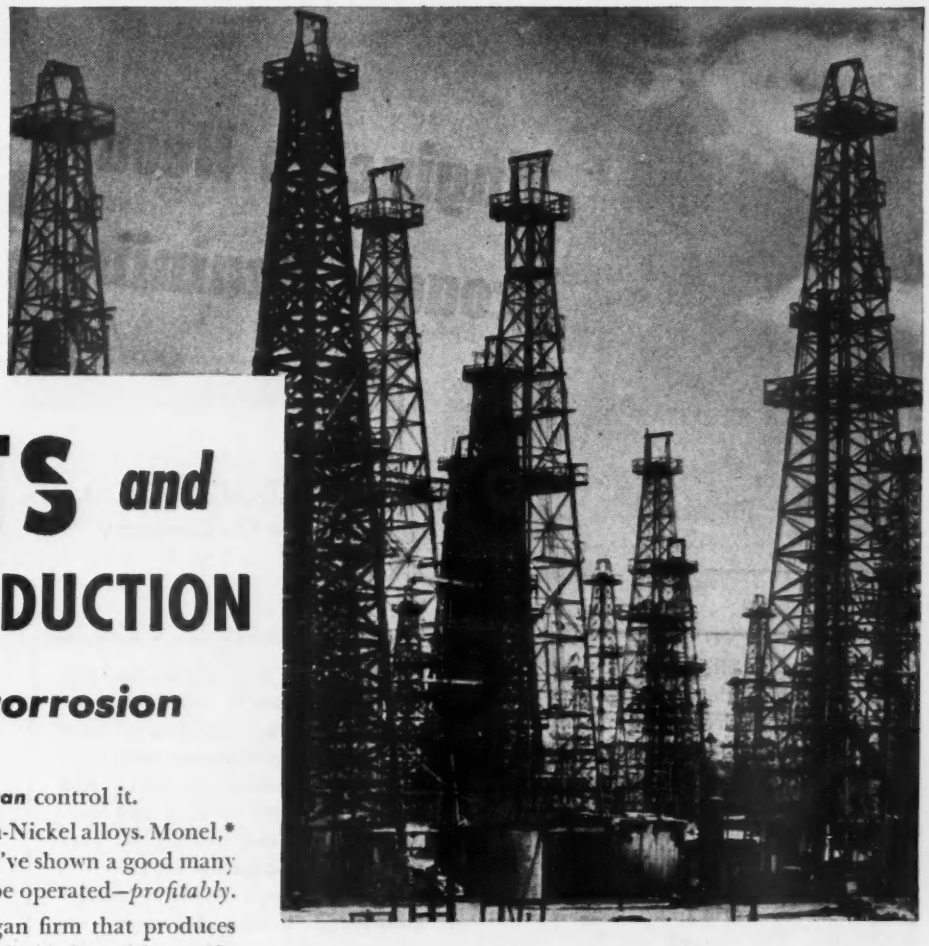
Demand for and Supply of All Oils, Crude Oil, Motor Fuel, Kerosine, Fuel Oil, and Lubricants

Sources: U. S. Bureau of Mines except August and September, 1949, estimated with aid of A.P.I. reports

(THOUSANDS OF BARRELS)

ITEM	First 9 Months, 1948	First 9 Months, 1949	Percent Diff.
ALL OILS			
Domestic Production, Total	1,601,742	1,484,072	— 7.3
(Daily Average)	5,846	5,436	— 7.0
Crude Petroleum	1,495,130	1,372,068	— 8.2
(Daily Average)	5,457	5,026	— 7.9
Natural Gasoline	106,338	111,905	+ 5.2
(Daily Average)	388	410	+ 5.7
Benzol	274	99	— 63.9
(Daily Average)	1	.....	.....
Imports, Total	133,786	164,130	+ 22.7
(Daily Average)	488	601	+ 23.1
Crude Petroleum	89,051	113,703	+ 27.7
(Daily Average)	325	416	+ 28.0
Refined Products	44,735	50,427	+ 12.7
(Daily Average)	163	185	+ 13.5
Changes in Stocks, All Oils	+67,084	+28,906	.....
(Daily Average)	+245	+106	.....
Stocks, Beginning of Period	500,800	605,189	+ 20.8
Crude Petroleum	230,654	256,254	+ 11.1
Refined Products	265,850	343,356	+ 29.1
Natural Gasoline	4,296	5,579	+ 29.8
Stocks, End of Period	567,884	634,095	+ 11.6
(Days' Supply)	93	107	+ 15.0
Crude Petroleum	237,302	258,897	+ 9.1
Refined Products	324,295	367,698	+ 13.4
Natural Gasoline	6,287	7,500	+ 19.3
Demand, Total	1,668,444	1,619,296	— 2.9
(Daily Average)	6,089	5,931	— 2.6
Exports, Total	103,478	92,950	— 10.2
(Daily Average)	377	340	— 9.8
Crude Petroleum, Total	30,176	24,600	— 18.5
(Daily Average)	110	90	— 18.2
Refined Products, Total	73,302	68,350	— 6.7
(Daily Average)	267	250	— 6.4
Domestic Demand, Total	1,564,966	1,526,346	— 2.5
(Daily Average)	5,712	5,591	— 2.1
CRUDE PETROLEUM			
Supply:			
Domestic Production, Total	1,495,130	1,372,068	— 8.2
(Daily Average)	5,457	5,026	— 7.9
Imports, Total	89,051	113,703	+ 27.7
(Daily Average)	325	416	+ 28.0
Change in Stocks	+6,648	+2,643	.....
(Daily Average)	+25	10	.....
Stocks, Beginning of Period	230,654	256,254	+ 11.1
Stocks, End of Period	237,302	258,897	+ 9.1
(Days' Supply)	41	49	+ 19.5
Supply, Total	1,577,533	1,483,128	— 6.0
(Daily Average)	5,757	5,433	— 5.6
Demand:			
Runs to Stills, Total	1,509,740	1,447,164	— 4.1
(Daily Average)	5,510	5,301	— 3.8
Domestic Crude	1,422,685	1,334,144	— 6.2
(Daily Average)	5,192	4,887	— 5.9
Foreign Crude	87,055	113,020	+ 29.8
(Daily Average)	318	414	+ 30.2
Exports, Total	30,176	24,600	— 18.5
(Daily Average)	110	90	— 18.2
Transfer to Fuel Oil Stocks	19,502	5,923	— 69.6
(Daily Average)	71	22	— 69.0
Distillate Fuel Oil	2,672	2,101	— 21.4
Residual Fuel Oil	16,830	3,822	— 77.3
Used as Fuel, and Losses	18,115	5,441	— 70.0
(Daily Average)	66	20	— 69.7
Demand, Total	1,577,533	1,483,128	— 6.0
(Daily Average)	5,757	5,433	— 5.6
KEROSINE			
Production, Total	90,491	72,317	— 20.1
(Daily Average)	330	265	— 19.7
Percent Yield from Crude	6.0	5.0	.....
Imports, Total	135	.....	.....
(Daily Average)	.....	.....	.....
Change in Stocks	+8,455	+3,218	.....
(Daily Average)	+30	+12	.....
Stocks, Beginning of Period	17,722	23,895	+ 34.8
Stocks, End of Period	26,177	27,113	+ 3.6
(Days' Supply)	87	107	+ 23.0
Demand, Total	82,171	69,099	— 15.9
(Daily Average)	300	253	— 15.7
Exports, Total	2,729	2,075	— 24.0
(Daily Average)	10	8	— 20.0
Domestic Demand	79,442	67,024	— 15.6
(Daily Average)	290	245	— 15.5

ITEM	First 9 Months, 1948	First 9 Months, 1949	Percent Diff.
MOTOR FUEL			
Production, Total	680,702	714,681	+ 5.0
(Daily Average)	2,484	2,618	+ 5.4
Refinery Gasoline, Total	605,241	634,661	+ 4.9
(Daily Average)	2,209	2,325	+ 5.2
(Yield from Crude	40.1	43.8	.....
Natural Gasoline, etc.	106,338	111,905	+ 5.2
(Daily Average)	388	410	+ 5.7
Less Sales of L.P.G.	29,790	30,215	+ 1.4
Less Transfers Cycle Prods.	1,361	1,769	+ 30.0
Benzol	274	99	— 63.9
Imports, Total	72	.....	.....
(Daily Average)	.....	.....	.....
Change in Stocks	+1,134	+2,962	.....
(Daily Average)	+4	+11	.....
Stocks, Beginning of Period	87,407	101,001	+ 15.5
Finished Gasoline	83,111	95,422	+ 14.8
Natural Gasoline	4,296	5,579	+ 29.9
Stocks, End of Period	88,541	103,963	+ 17.4
(Days' Supply)	36	40	+ 11.1
Finished Gasoline	82,254	96,463	+ 17.3
Natural Gasoline	6,287	7,500	+ 19.3
Demand, Total	679,640	711,719	+ 4.7
(Daily Average)	2,480	2,607	+ 5.1
Exports, Total	28,326	31,650	+ 11.7
(Daily Average)	103	116	+ 12.6
Domestic Demand	651,314	680,069	+ 4.4
(Daily Average)	2,377	2,491	+ 4.8
DISTILLATE FUEL OIL			
Production, Total	280,669	245,306	— 12.6
(Daily Average)	1,024	898	— 12.3
Percent Yield from Crude	18.6	17.0	.....
Transfers from Crude	2,672	2,101	— 21.4
(Daily Average)	10	8	— 20.0
Imports, Total	2,032	1,294	— 36.3
(Daily Average)	7	5	— 28.6
Change in Stocks	+25,239	+11,817	.....
(Daily Average)	+92	+43	.....
Stocks, Beginning of Period	51,081	71,381	+ 39.7
Stocks, End of Period	76,320	83,198	+ 9.0
(Days' Supply)	80	96	+ 20.0
Demand, Total	260,134	236,884	— 8.9
(Daily Average)	949	868	— 8.5
Exports, Total	17,691	9,725	— 45.0
(Daily Average)	64	36	— 43.7
Domestic Demand	242,443	227,159	— 6.3
(Daily Average)	885	832	— 6.0
RESIDUAL FUEL OIL			
Production, Total	348,359	315,003	— 9.5
(Daily Average)	1,271	1,154	— 9.2
Percent Yield from Crude	23.1	21.8	.....
Transfers from Crude	16,830	3,822	— 77.3
(Daily Average)	61	14	— 77.0
Imports, Total	40,654	47,937	+ 17.9
(Daily Average)	148	176	+ 18.9
Change in Stocks	+20,914	+3,989	.....
(Daily Average)	+76	+15	.....
Stocks, Beginning of Period	47,091	63,993	+ 35.9
Stocks, End of Period	68,005	67,982	.....
(Days' Supply)	48	51	+ 6.3
Demand, Total	384,929	362,773	— 5.7
(Daily Average)	1,404	1,329	— 5.3
Exports, Total	9,263	10,125	+ 9.3
(Daily Average)	33	37	+ 12.1
Domestic Demand	375,666	352,648	— 6.1
(Daily Average)	1,371	1,292	— 5.8
LUBRICANTS			
Production, Total	38,293	33,034	— 13.7
(Daily Average)	139	121	— 12.9
Percent Yield from Crude	2.5	2.3	.....
Change in Stocks	+1,183	+7	.....
(Daily Average)	+4	.....	.....
Stocks, Beginning of Period	7,701	9,843	+ 27.8
Stocks, End of Period	8,884	9,850	+ 10.9
(Days' Supply)	66	81	+ 22.7
Demand, Total	37,110	33,027	— 11.0
(Daily Average)	135	121	— 10.4
Exports, Total	10,117	9,850	— 2.6
(Daily Average)	37	36	— 2.7
Domestic Demand	26,993	23,177	— 14.1
(Daily Average)	98	85	— 13.3



How YOU can

CUT COSTS and INCREASE PRODUCTION

...by controlling corrosion

You can't stop corrosion. But you ***can*** control it.

Install equipment made with high-Nickel alloys. Monel,* for example. Or "K"* Monel. They've shown a good many producers that corrosive wells can be operated—*profitably*.

Take the experience of a Michigan firm that produces from the Sylvania formation a chemical brine with specific gravity of 1.28. At a depth of 2,400 feet, the pump they were using just didn't stand up. *But trouble ended when they installed a Reda pump equipped with a "K" Monel shaft and Ni-Resist diffusers.*

Then consider the story of this well in Louisiana. It had *plenty* of oil below the surface—but would only make gas on a ⅛" surface choke with 3,000 pounds pressure. Freezing of surface flow lines and connections was frequent. The allowable couldn't be produced.

After the operator installed an Otis Removable Bottom Hole Regulator made of "K" Monel, surface pressure dropped to 1,350 psi. Freezing stopped. Gas-oil ratio was cut to a point where almost no oil was wasted. The regulator stayed in the tube 57 months, produced 869,839 barrels before it was pulled for inspection. *It was found in first-class condition.*

Of course, corrosion resistance is only one quality that contributes to the dependability of equipment like this. Extra strength, hardness, toughness or resistance to wear and abrasion may also be vital. *In high-Nickel alloys, you get the combination of properties you need.* Through years of use in the toughest areas of the mid-continent district, Monel and "K" Monel have proved especially well adapted to combat harsh conditions.

Monel, in addition to being rustproof and highly resistant to sour crudes, withstands the cutting action of high-pressure gas, provides unusually good resistance to erosion and abrasion by entrained solids. **"K" Monel** brings you those same characteristics *plus* extra strength and hardness. It is non-magnetic; by heat treatment its tensile strength can be developed to 140-170,000 psi, its hardness to 265-320 Brinell.

Both Monel and "K" Monel are used for parts subject to alternating stresses in the presence of corrosives. Their retention of good fatigue strength is particularly evident in extended equipment life.

The full story of how you can put these and other INCO Nickel Alloys to work for you is contained in our new, illustrated booklet, *Controlling Corrosion in Petroleum Production Equipment.* It brings you typical performance and service stories of Nickel Alloys in a variety of corrosive uses. It discusses the important factors in reducing maintenance and replacement costs. There are sections dealing with exploration and drilling, pumping, and gas control.

The booklet tells, too, how you can get free technical advice on the selection of materials for severe service, and contains a listing of valuable Technical Bulletins that are available to you on request. Write for your copy—*now.* We'll get it into the next outgoing mail. *Reg. U. S. Pat. Off.

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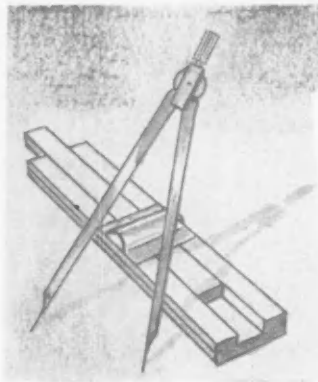

Engineers Need Broader Training

By L. W. LEDGERWOOD, JR.
The Carter Oil Company

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IN ORDER that an engineer may fulfill his obligations to society, he must be more than a technician. He must be also a well-rounded individual and citizen, taking an active and constructive part in civic and economic affairs and making his personality and leadership count.

It is not enough for him to possess knowledge. He must also possess the wisdom with which to apply his knowledge, for the benefit of society. This wisdom can be most certainly assured for the engineer by a well-balanced professional education, with liberal arts courses emphasized along with technical courses in college.

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Personality Traits

The importance of these intangible qualities can be shown in many ways. M. M. Boring, Manager of Technical Personnel Division of General Electric, in a letter to the writer, said: "Failures in the company with which I am associated are seldom if ever caused by lack of technical ability. Practically all failures among professional people are because of what may be called 'character or personality' defects." He qualifies his statement by saying that an effort is made to employ only technically qualified men so there will be no failures on that score. However, it is significant that failures, when they do occur, are usually caused by circumstances which only the individual can control.

A study of Figure 1 emphasizes the importance of proper character development. Data is based on a pamphlet prepared by Paul W. Boynton, Supervisor of Employment for Socony-Vacuum Oil Company, entitled: "So You Want a Better Job?" and covers a survey of office and clerical help of 76 large corporations in this country. It will be noted that lack of specific skills accounts for only 10.1 percent of the causes for discharge, while character traits account for the remaining 89.9 percent. Hence, whether the engineer is self-employed or in the employ of another, the importance of personal development cannot be overemphasized.

Extra-curricular Activities

Unfortunately, the intangibles of leadership, personality and character cannot be obtained through slide rule manipulation and long hours of academic study. The only way these qualities can be developed is through active participation in extra-curricular activities.

A survey was made of extra-curricular activities of engineering students at Oklahoma A. and M. College which indicates that 36.1 percent of the male students on the campus are engineers. Only in two types of organizations, church and fraternal, does the percentage of engineers begin to approach this base percentage of 36.1 percent. As a group engineers do not avail themselves of extra-curricular activities so necessary to personal development. As a matter of fact the actual number of engineers in each group is small compared to the engineering enrollment of 2649 students.

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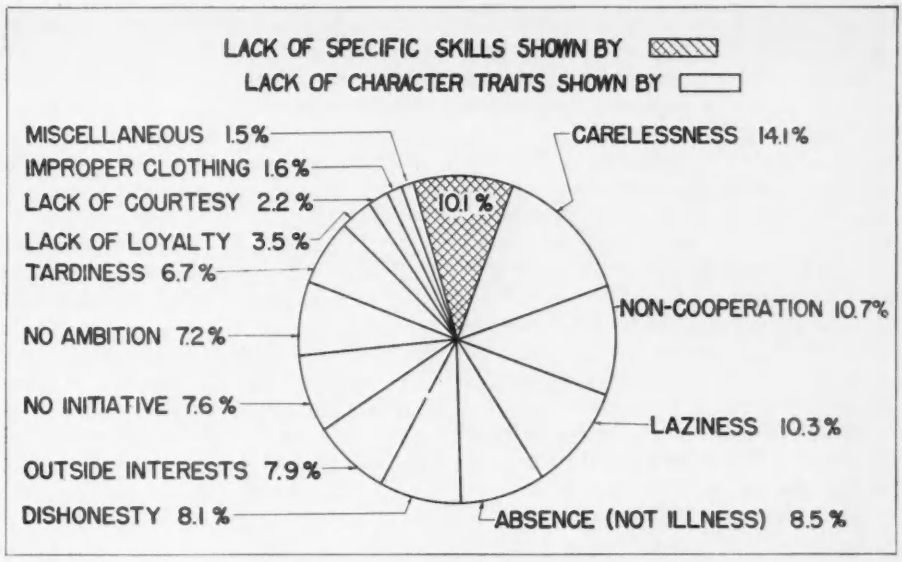


FIGURE 1. Reasons for discharge

Fraternal Activities

A comprehensive study has been made of the fraternal activity of students in a Southwestern university embracing the schools of Agriculture, Arts and Sciences, Commerce and Engineering, these being the most important and comprising 91 percent of all the male students. The study shows that engineers comprise 36.1 percent of the male students on the campus but account for only 22.5 percent of the men in social fraternities. In the case of commerce students just the opposite is true; commerce students comprise 17.8 percent of the total men students on the campus but they make up 29 percent of the total social fraternity membership. In the schools of Agriculture and Arts and Sciences the ratios are evenly divided.

From this analysis it is plainly evident that students in schools other than engineering are more active in extra-curricular activities than engineering students. This fact is having serious consequences as today's engineers graduate into the professional world.

Indeed, Lee H. Hill, publisher of *Electrical World*, goes so far as to say: "One of the main reasons manufacturers have developed graduate training courses has been that the young engineering graduate has had many rough corners to knock off and has needed to become accustomed to rubbing shoulders with other people." He definitely implies that the engineering student is not developing his personality and character to the fullest extent.

In the writer's opinion the curriculum forced upon engineering students contributes in no small measure to this lack of character and personality development. Consider Figure 2 prepared from information obtained from college catalogues and through correspondence. This chart indicates the relative number of clock hours per week required by various courses of study and was prepared on the basis of the following assumptions: (1) that the student spends two hours outside study per hour of lecture (theory); and (2) that the student spends one-half hour of outside preparation per hour spent in laboratory. An exception was made in the case of the Law curriculum; since it had no lab work and was a graduate course of study, three hours outside study per hour of lecture were allowed. "Class hours" represents the total class and laboratory time required of the student per week.

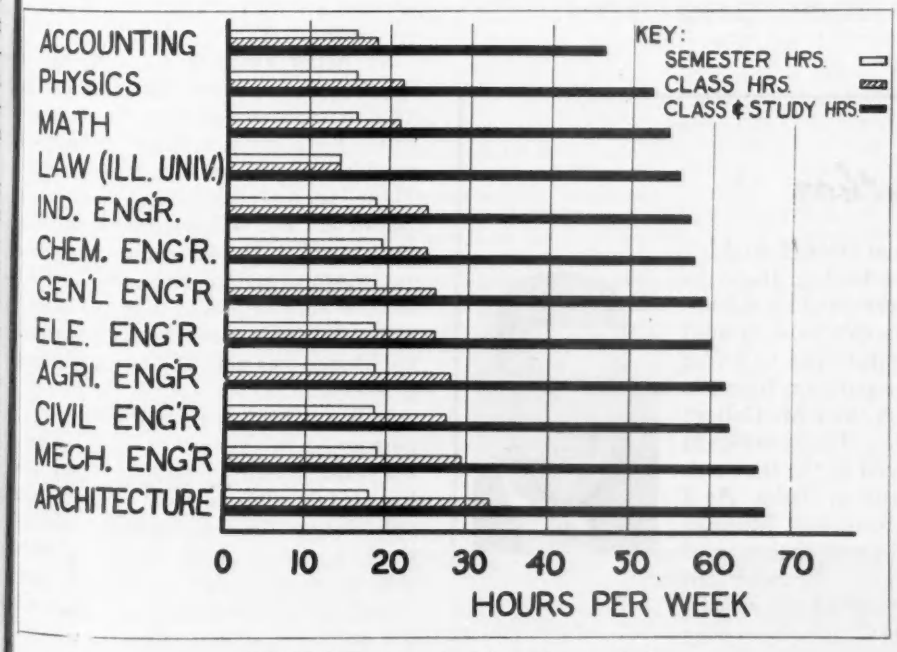
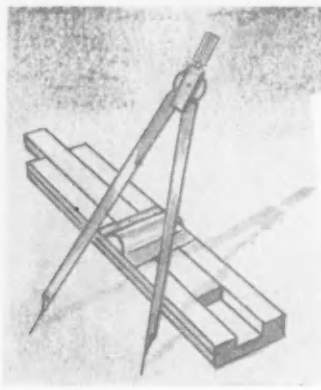


FIGURE 2. Time required by various curricula.

A comparison of a mechanical engineering and an accounting curriculum shows that the mechanical engineering curriculum requires 19.5 hours more of total time per week than does the accounting. Similarly, a mechanical engineering curriculum requires ten more hours per week total time than does a law curriculum, even figuring three hours of study per hour of lecture in the case of law and only two hours study per hour of lecture in the case of mechanical engineering. Hence, it is not surprising that the engineering student cannot find time for the character-developing activities engaged in by students of other professions.

Referring again to the definition of engineering, it is obvious that an engineer's background must make him technically proficient in "the control of the forces and materials of nature." It can be conceded that the technical proficiency of present-day graduates is sufficient, when compared to their proficiencies in other fields.

The final stipulation made by society for engineers is that all their actions be "for the benefit of the human race." It is this stipulation that places the en-



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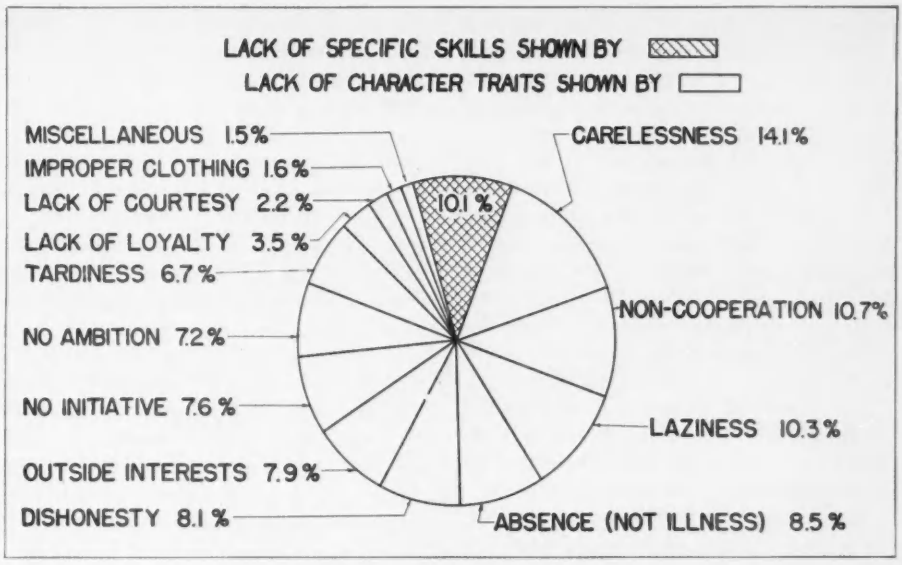

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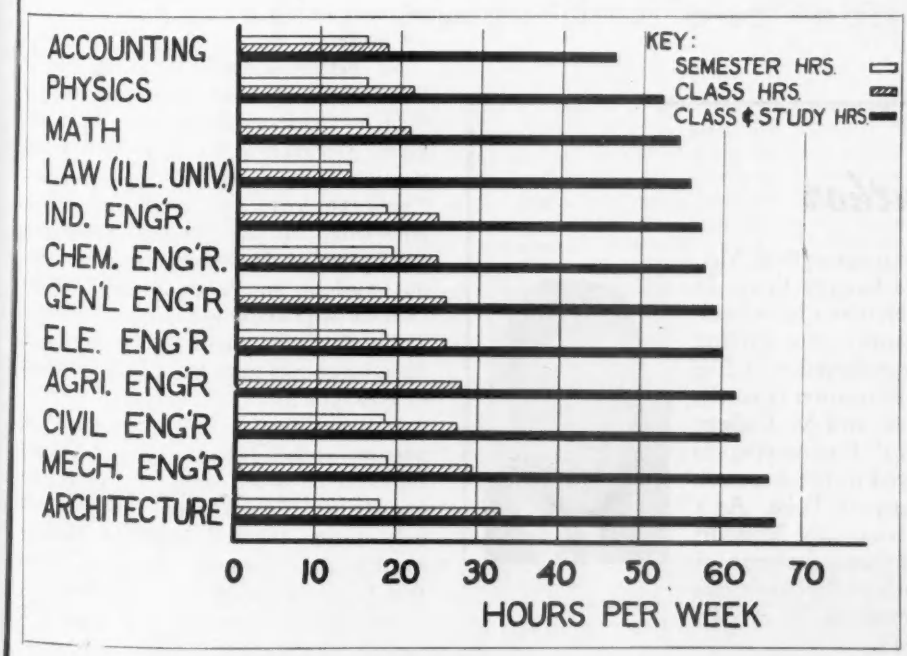


FIGURE 2. Time required by various curricula.

A comparison of a mechanical engineering and an accounting curriculum shows that the mechanical engineering curriculum requires 19.5 hours more of total time per week than does the accounting. Similarly, a mechanical engineering curriculum requires ten more hours per week total time than does a law curriculum, even figuring three hours of study per hour of lecture in the case of law and only two hours study per hour of lecture in the case of mechanical engineering. Hence, it is not surprising that the engineering student cannot find time for the character-developing activities engaged in by students of other professions.

Referring again to the definition of engineering, it is obvious that an engineer's background must make him technically proficient in "the control of the forces and materials of nature." It can be conceded that the technical proficiency of present-day graduates is sufficient, when compared to their proficiencies in other fields.

The final stipulation made by society for engineers is that all their actions be "for the benefit of the human race." It is this stipulation that places the en-

gineer of today in a truly professional status, for the true mark of any profession is its ministry to the human race. In order for engineers to measure up to this, their background must include a sound knowledge of subjects ordinarily associated with a liberal arts education, such as history, philosophy, psychology, economics, sociology, etc.

Today's engineering students receive very little instruction in the liberal arts. Correspondence and college catalogs indicate that graduating engineers from a Southwestern university have only about one-third as much space devoted in their curricula to the study of non-technical subjects as have their professional brothers in the school of law.

Thus, the results of this analysis indicates that today's engineering students are receiving adequate instruction in only one of the three fields in which society will expect them to be proficient, namely, technical skill. The graduating engineer is far behind his contemporaries who are graduating from other professional schools, in his ability to shoulder the obligations immediately thrust upon him by society.

The graduating engineer, in fact, is perilously close to being a technician, rather than an engineer.

Suggested Solution

One solution to this problem involves two changes in existing engineering curricula. In the first place engineering education should be placed on a full professional level and five years should be allotted for study to obtain a bachelor's degree in engineering. This is not as radical a change as might be supposed. The late Professor E. C. Baker compiled statistics pertaining to mechanical engineering graduates from Oklahoma A. & M. College which show that only 25 percent of the students in any given class completed the requirements for graduation in the allotted four years; that 50 percent of the students required four and one-half years to complete the requirements; and that the remaining 25 percent of the students consumed five years in obtaining their degrees.

If appropriate highly specialized courses are deleted from the curriculum and if in their stead certain basic liberal arts courses be substituted in such a manner as to increase only slightly the total number of hours required for graduation, much is to be gained. The student will have more time for normal well-rounded development outside the classroom, and in the classroom his perspective will be greatly broadened.

It is believed that the maximum benefit will be obtained if the liberal arts courses are spaced throughout the entire five years of work and not isolated in the first two or three years of college work. If this latter course of action is followed, the courses will become survey courses to be endured by the student as painlessly as possible. On the other hand, if these liberal arts courses are integrated throughout the entire period of college work along with the technical courses, and if these liberal arts courses are designed to cause the engineering student to have the ability and desire to participate in these non-engineering fields, then the student is much more apt to maintain his interest in the liberal arts courses and to profit from them. This is especially true if professors in technical subjects hold the student strictly accountable for proper use of English in written and oral reports, and if the student always is made conscious of the economic, social, moral, and psychological ramifications of the technical problem on which he is working.

The other change in engineering curricula required for the solution of this problem is academic recognition of the student's extra-curricular activities. If the first suggested change in engineering curricula is followed, the student would have a little more free time to devote to extra-curricular activities. However, it is not enough to assume that the student will voluntarily engage in these activities. The student must be motivated to so engage. The most successful form of motivation is a system which will increase the student's classroom grade in direct proportion to his extra-curricular activity.

As a case in point, one engineering school credits the student with a perfect daily examination grade in a subject of the student's selection for each Student Branch meeting of the AIEE in which the student participates. This is an example of one form of academic recognition of extra-curricular activity.

Current Trend

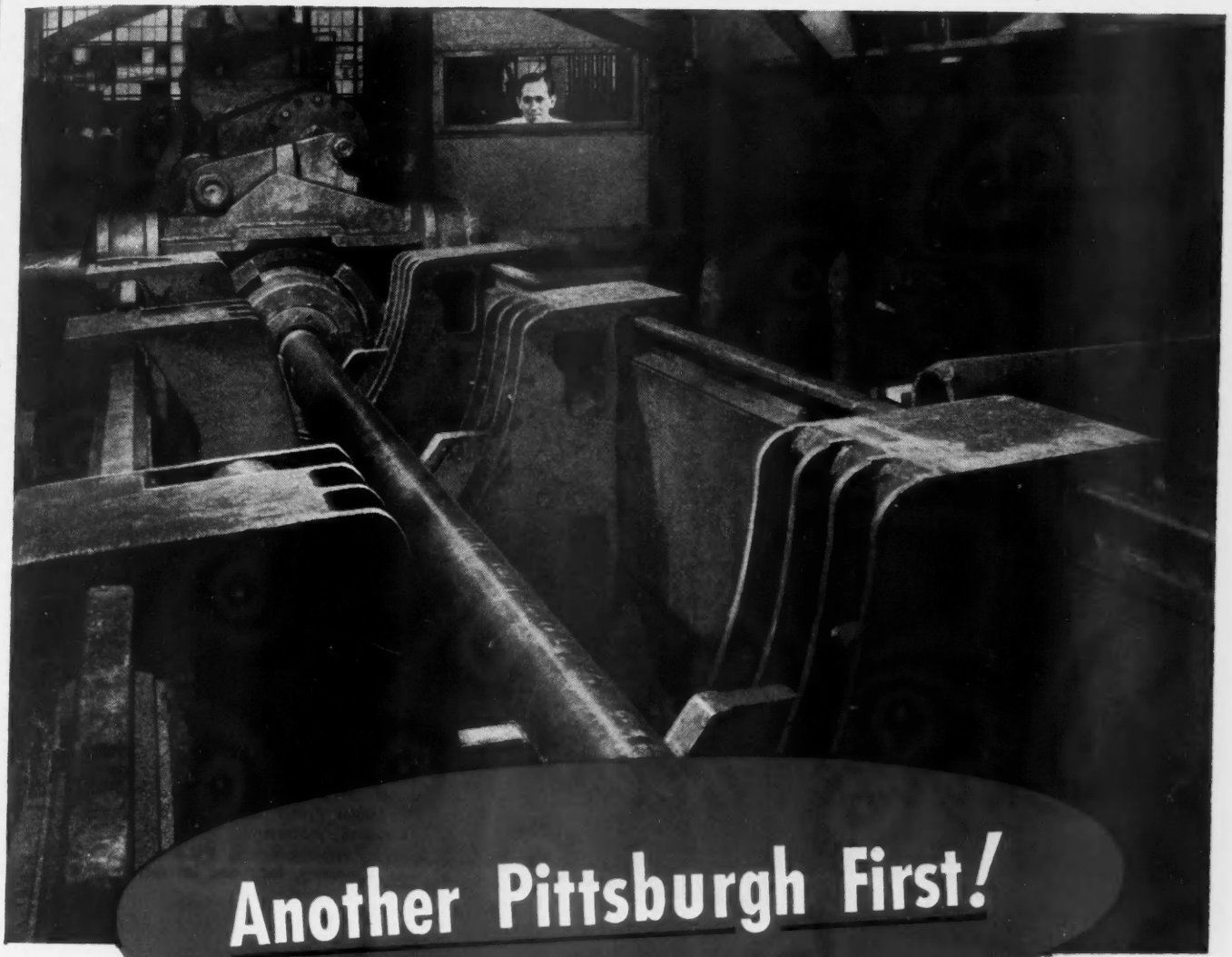
The current trend is a step in the direction of these suggested changes. Recently, at least four schools, the University of Minnesota, Cornell, Ohio State, and Rice, have changed to programs requiring five years' work for an engineering degree. One of the leading groups in the field of integrated technical and functional liberal arts education is the faculty of the Carnegie Institute of Technology. Educators and engineers in industry are realizing the necessity of turning out engineers who are well-rounded individuals in addition to possessing technical skills. Hence, as one approach to the problem, experiments are being made with the new five-year type of curriculum. This type of curriculum is imperative if the divorce between knowledge and wisdom is to be set aside.

No better example is to be had of the divorce of knowledge and wisdom than in Germany during the Nazi Regime. Germany's colleges turned out capable technicians in great numbers. These technicians possessed unique knowledge and skill, as their subsequent work testified. However, they were without wisdom, and it made no difference to them who employed them, or to what anti-social ends their highly developed knowledge was put. The result is known to everyone.

It is not enough for our engineers to possess knowledge; they must possess the wisdom with which to apply this knowledge. This wisdom can be born only during the well-balanced development of a professional education. When this is provided for the eligible youth of our nation, then, and only then will our schools graduate engineers who will continue to be a blessing to society.

About the Author

L. W. LEDGERWOOD, JR., was born in Springfield, Mo., and attended Southwest Missouri State College there. In 1941, after two years of college, he interrupted his schooling to join Spartan School of Aeronautics as a ground instructor. Three years later he was transferred to active duty with the Army Air Forces. Upon separation from the service in 1946 he entered Oklahoma A. and M. College and obtained his degree in Mechanical Engineering in January, 1949, and is currently employed in the Research Laboratory of The Carter Oil Company at Tulsa. As a student he received one scholarship at Southwest Missouri State and two at Oklahoma A. and M.; was chairman of the Oklahoma A. and M. Student Branch of the American Society of Mechanical Engineers, and received the ASME Undergraduate Student Award for 1948.



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Again Pittsburgh Steel Company is the first to provide a method of adequately testing casing for deep wells to give you fewer leakers and long service with safety. This new development will save you time and money in the field. It is made possible with our new Hydrostatic Testing equipment capable of testing casing *in tension* up to 10,000 PSI.

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Pittsburgh Steel Company

The balancing of cylinder loads is demonstrated on a diesel engine. Left to right, F. C. Burns, motorman, W. H. Black Drilling Company; Bill Martin, engineman, Rowan Drilling Company., Inc.; Jake Massie, driller, W. H. Black Drilling Company; Walter T. Henderson, driller, Sawyer Drilling Company; Clifton Thompson, motorman, W. H. Black Drilling Company; Raymond Baker, engineman, Rowan Drilling Company, Inc.; and Instructor Boatman.

By JOHN A. BOATMAN

ODESSA, Texas, is the site of the nation's first school for the training of oil field drilling engine operators. The 36-hour course is being offered by Odessa College, in conjunction with The University of Texas, State Board for Vocational Education, six engine manufacturers and their local distributors. The training school was set up at the request of the American Association of Oilwell Drilling Contractors, whose Committee on Drilling Engine Training sponsored the project.

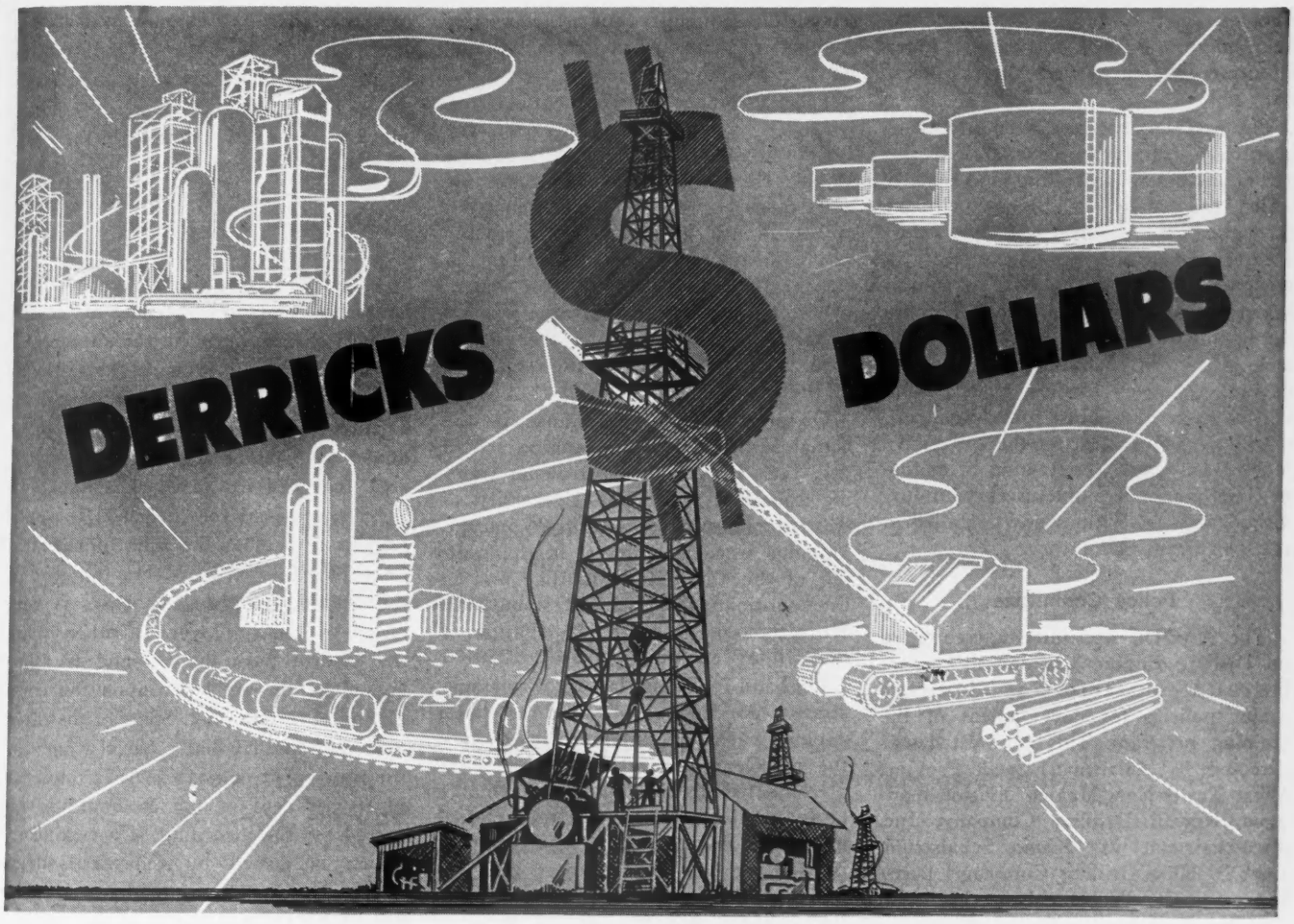
Classes are held in three-hour sessions, four days per week, for three weeks. Morning classes are from 9:00 a.m. to 12:00 noon and are for evening tour workers. Night classes are held from 7:00 to 10:00 p.m. and are for day tour and morning tour workers. In addition to the regular course, which requires three weeks' work, the training is offered also in a condensed period of eight hours per day for 4½ days. This latter program is designed for those contractors whose drilling rigs are located at such a distance from Odessa that the daily drive in for classes would not be possible. The workers usually arrange for someone to "double over" for them for five days in order that they may stay in Odessa during the entire training period.

From the opening of the school on July 11, 1949, three morning groups and three night groups completed the course and graduates totaled 69. Eighteen were enrolled in the class scheduled to complete the course October 6. The next regular class began work October 17.

The school was set up primarily for the training of engine operators, termed motormen or enginemen by industry. However, some of the participating contractors believed that the inclusion of their drillers and toolpushers would be more desirable, and as a result, the first 42 graduates listed the following job classifications: drillers, six; drilling con-

A SCHOOL for training oil field drilling engine operators has been established at Odessa College, Odessa, Texas, in conjunction with the University of Texas. It was sponsored by the American Association of Oilwell Drilling Contractors, which similarly had sponsored drilling mud schools throughout the drilling industry.

The school at Odessa College is expected to continue operation for a year or more. The regular course requires three weeks, and the training is offered also in a condensed period of eight hours per day for 4½ days. In this training, engines most commonly used in the Permian Basin are studied, and conditions affecting engine operation in the region are given special attention.



. . . and the *Drilling Contractor*

If ever there has been an industry whose growth is sparked by individual efforts, it is the giant Petroleum Industry, now in its 90th year. Throughout its long and colorful history, the Drilling Contractor has been the Industry's most aggressive individual. Perseverance, determination and unswerving confidence in their own belief, has led to the discovery of many of our greatest oil fields by Drilling Contractors.

Many of the millions of dollars required by the Petroleum Industry for the production and development of its products have come from Texas Banks. The City National Bank of Houston, located in this great oil center of the Nation, is broadly experienced in oil and gas financing. The Oil and Gas Department's experience with the industry and knowledge of its financial requirements assures a comprehensive understanding of your problem which leads to prompt attention.

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tractors, one; drilling superintendents, one; engineers, two; mechanics, four; motormen, 19; toolpushers, three; others, six.

The AAODC had long been interested in such a training program, since the earlier success of the drilling mud schools which previously had been conducted throughout the drilling industry. Once the need for drilling engine training was recognized, the University of Texas was asked to assume responsibility for the development of the entire program. This included the acquisition of live drilling engines, cut-away models, charts, films and other training aids. John Woodruff, petroleum coordinator for the University of Texas, secured cooperation of engine and equipment manufacturers who furnished six new engines now installed in the petroleum laboratory.

Policy Committee

The AAODC appointed a committee on Drilling Engine Training to contact interested contractors and formulate major policies for development of the training program. This committee was directed by Chairman Cecil Provine, West Texas-New Mexico division manager, Rowan Drilling Company, Inc. Vice-chairman was Bruno Schabarum, Carl B. King Drilling Company; treasurer was H. W. Davidson, Davidson Drilling Company; and secretary was Howard Butler, student counsellor for Odessa Public Schools. Other committee members included 17 representatives of drilling contractors, supply houses, machine shops and engine service firms.

A Sub-Committee on Planning was appointed, whose duties included the development of the course content for the school. This committee consisted of seven members of local service firms and maintenance mechanics, including the writer.

The customary employment of the writer is maintenance supervisor for Rowan Drilling Company, Inc., Fort Worth. He has been given a six months' leave of absence in order to instruct the students until a permanent instructor can be located and employed by Odessa College. It is expected that the school will continue operations for one year or more. Ample registrations are on file to assure its operation for the remainder of the year.

Of most valuable assistance in the actual setting up of the engine school was Jack L. Wiggins, petroleum training specialist from The University of Texas, and an assistant to Woodruff. Wiggins was instrumental in the writing of the Instructor's Outline and in the coordinating of various training aids. He also assisted in the installation of the drilling engines.

On hand for actual laboratory demonstration are three gas and three diesel engines, each of a different make. Since the petroleum laboratory is located in a residential district, ample gas volume is not available to use that type of fuel in the gas engines. As a result, butane is used for fuel, and is stored in a 250 gallon tank. Diesel fuel is stored in a tank of like capacity.

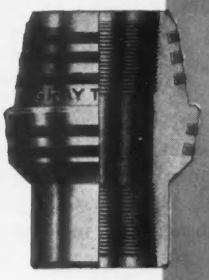
The six engines represent about 90 percent of the different makes of drilling engines used in the Permian Basin. This fact was learned as the result of a survey which was conducted prior to the requisitioning of the engines for use at the school. Each drilling contractor was asked to report on the makes and numbers of drilling engines used by his firm. This enabled the committee to select the engines on a demand basis and prevented the teaching of engines which were not in operation in the area. Obviously, the latter course would have placed the school on a sales promotion basis, which is strictly avoided. At least one engine manufacturer who requested to place his engine in the school could not be accommodated because his engine had not been reported in the survey. All engines are equipped with skids, radiators and maximum silencers. Since the location of the school has been mentioned as being in a densely populated area, the need for silencers is apparent.

An enrollment fee of $20.00 for each student is paid at the time of registration. This fee partly covers the cost of the training and in some cases is paid direct by the employer. In other cases, the student pays the fee and is reimbursed by the employer upon the completion of the training. Some of the firms also pay the student's basic wage for the time spent in classes. An attendance of 80 per cent of the 36 hours is required for the awarding of a certificate, which is issued by Odessa College. Murry H. Fly, superintendent of public schools at Odessa for 24 years, recently was named president of the college.

During the first session, the student is reminded that the primary objective of the training is fundamentals of engine care and maintenance. No attempt is made to teach applied mechanics or any phase of major repair and overhaul which usually is done in the shop or at the rig by a skilled mechanic. Safety and cleanliness are stressed and repeated throughout the course. Also covered during the first day is a canvass of the students on the duties of the engine operator. The reduction in drilling costs of one cent per foot, or one cent per man-hour of labor, should more than pay for the cost of this training. One of the aims of the training is to teach the operator in the simple adjustments and trouble-shooting methods in order to avoid the expensive and ofttimes unnecessary trips to the rig by maintenance mechanics.

Definition of terms is covered thoroughly. Because of lack of previous training, some engine operators have such limited knowledge of nomenclature that it is very difficult for the mechanic to judge the nature of the trouble over the telephone, and in some cases, a trip to the rig by the mechanic becomes necessary before the proper tools can be

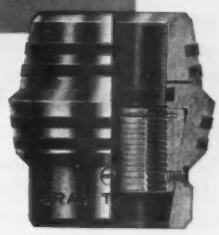
Instructor Boatman explains the construction and functions of a butane vaporizer, "B" regulator and carburetor during a lecture session on Gas Engine Fuel Systems.



1

Threaded "Boll Weevil" Casing Hanger—Patent No. 2,082,413

GRAY SYSTEMS OF WELL CONTROL INCLUDE THESE DEVELOPMENTS



Slip Test Weld Type "Boll Weevil" Casing Hanger — Patent No. 2,207,469 **2**

These simple combinations of casing hanger and seal are made of long-lived, high-strength materials in a design that subjects them only to the minimum pressure area.

1. Regular threaded "Boll Weevil" type Casing Hanger

2. Interchangeable with the threaded "Boll Weevil" Casing Hanger shown above, is the slip suspension, test-weld "Boll Weevil" Casing Hanger. The double tapered construction provides essentials to safety, such as:

(a) A positive seal insured by the tapered design

(b) Reduction of pressure-subject areas

(c) Avoidance of the causes of welding failure by reducing the section of metal at the point of welding to allow uniform cooling of hanger and casing.

THE WHOLE IS THE SUM OF ITS PARTS

These parts, like other Gray equipment, are parts of a complete, coordinated system of well control. This system is designed to fulfill two specific functions: 1) to provide temporary seals for control unit permanent seals are effected and 2) to allow for the removal of each part as soon as it completes its operating function, and thus to eliminate the operating hazards connected with its use.

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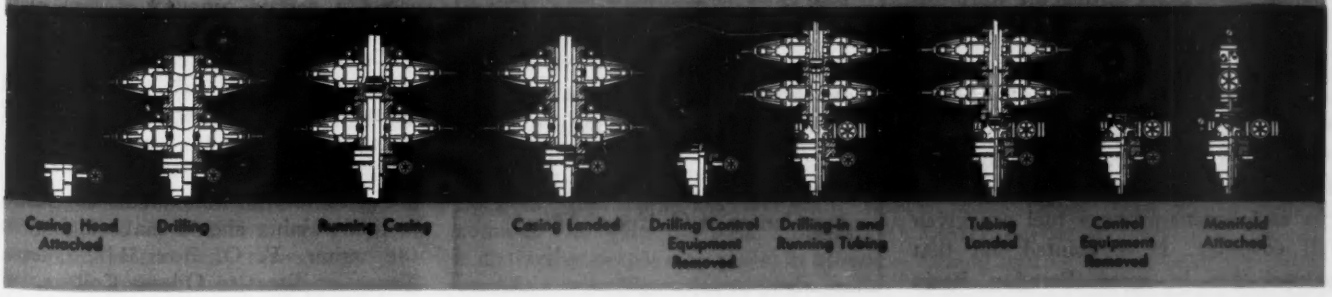


selected and the correct repair parts can be purchased.

Starting Systems

Engine Starting Systems is the topic for discussion during the second day's work. This covers the principles of operation and the care of electrical motors, generators, voltage regulators, wiring harness and batteries. Students are instructed how to correct reversed polarity in generators. They are cautioned to use closed lights to check battery water level at night. Air motors and air distributing systems used for cranking the engine are explained. Finally, the use of gasoline starting engines is covered.

Engine Lubrication is covered thoroughly. A sound film is shown which outlines the mechanics of lubrication. A silent color film is shown which demonstrates the principle of the wedged or tapered oil film and explains the coefficient of friction. Charts are used to explain the chemical and molecular construction of lubricating oils. Students are shown how cold oil will not lubricate properly and will not circulate through the filters until the operating temperature of the engine has reduced the viscosity of the oil. They are shown that the only sure method of determining the correct time to change lubricating oil is through laboratory testing. Also covered in this chapter is accessory lubrication, including upper valve lubricants, force feed lubricators, fan bearings, water pump bearings and glands, generators, starting motors and clutches.

Cooling is another subject that is dealt with at great length. The importance of filtering and treating make-up water is stressed. Students are taught how to back wash and recharge water softeners. The use of soap tests to determine the need for recharging is explained. Of great importance to engine lubrication is the maintaining of proper cooling water temperatures. The use of radiator shutters or blinds for cold weather operation is general practice. During hot weather, when prevailing winds are adverse, the use of wet excelsior pads can be employed to good advantage. Students are encourage to warm an engine slowly because most of the damage to crankcase oil takes place during the warm-up period when cylinder blow-by is excessive.

Gas Fuel

Gas Fuel Systems are given complete attention during another session. Natural gas and butane-propane fuel are given full coverage. It is pointed out that natural gas in some Permian Basin fields is high in sulfur content and requires treating with scrubbers. Attention to oil bath type air cleaners is stressed, since this region is noted for its severe dust storms. By actual laboratory demonstration the student learns the correct adjustment for regulators and gas carburetors. Construction and functions of butane vaporizers are explained by colored charts and exploded views, as well as by the use of cut-away models. Heat content of various fuels is explained, and students learn to make proper adjustments when changing from one fuel to another of different BTU content. This session is closed with a short talk on the types and purposes of superchargers.

Diesel Fuel Systems are taken up next. This includes fundamentals of compression ignition. A sound film deals with the principle of combustion and the features of construction of a diesel engine. Students learn the methods used for bleeding air from fuel lines. They are taught how to balance the load within the cylinders by changing the metering of fuel by the pumps.

One of the most important subjects taught at the school is Gas Engine Ignition and Timing. The types and principles of magnetos come in for full discussion. Each student learns how to install and set the timing on a spare magneto. He is shown the importance of correct spark plug selection and proper spark plug gap setting. When a gas engine misfires, the student is encouraged to check ignition and is discouraged from changing the carburetion of fuel. Students are show how an inlet valve or an exhaust valve not in proper adjustment will affect the effective strokes of the engine during its operation. The session is closed with a sound film on ignition and spark plugs.

Speeds and Loading

Speeds and Loading is treated of mostly by lecture. Idling speeds and maximum governed speeds as recommended by the engine manufacturers are given. Methods of loading the engines in the laboratory are not available; however, the student learns to recognize an overloaded engine through the use of vacuum gauges, exhaust pyrometers and the interpretation of exhaust color. Critical speeds are explained, and students are taught how to recognize the characteristics of an engine that is being operated in a critical range.

Governors are covered in another chapter. A sound film is shown on mechanical governors. Hydraulic governors are explained by lecture and blackboard drawings. Most mechanical governors used on drilling engines are of the limiting speed type and control only the idling speed and the maximum speed. Intermediate speeds are controlled by the throttle.

Clutches are studied as the course is brought to a close. Attention is given to air clutches, friction clutches, fluid couplings and torque converters. The school has been loaned a small power take-off and a friction type clutch. These units are completely disassembled and are rebuilt during laboratory demonstration.

Local service representatives of the engine manufacturers are requested to spend a certain amount of time with the instructor during the third week of the course. This procedure allows the students to receive answers to technical questions about any specific engine and to lend weight to the subjects already covered during the training.

Contractors or individuals interested in this training should make inquiry to the writer, P. O. Box 3147, Odessa, Texas, or direct to Odessa College.

About the Author

JOHN A. BOATMAN, instructor at the Odessa Engine School, studied diesel engineering at the University of California, the Miami Naval Training Center, the General Motors Institute, Flint, Mich., and at the Armed Forces Institute at Madison, Wis. Because of his qualifications in this field he was selected to become instructor and was granted a leave of absence by the Rowan Drilling Company, Fort Worth, Texas, where his customary employment is maintenance supervisor. A native Texan, he was a Navy man during the war and besides serving aboard a patrol craft in the Mediterranean he also was an instructor at the diesel school of the Naval Training Center at Gulfport, Miss.

Lithologic Criteria of *Mississippian Rocks* in Western Kansas

By JOSEPH R. CLAIR
Great Lakes Carbon Corporation, Wichita, Kansas

THE MISSISSIPPIAN section affords important markers in Western Kansas, where active and significant development is under way. This important section and its component subdivisions can be identified on the basis of lithology, detailed sample work has shown. As an aid to geologists in correct correlation, this article presents some lithologic criteria for identification and subdivision of the section.

FOR years many geologists have considered the Mississippian as a top and bottom marker, with a varying thickness of very hard rock between. Detailed sample work over the past few years has shown that this section can be subdivided on the basis of lithology, just as it has been previously broken up by means of insoluble residues.

Because of significant developments in the general area and the possibilities of Western Kansas from an oil and gas producing standpoint, the writer presents some lithologic criteria for the identification and subdivision of the Mississippian section, in the hope that it will serve geologists in correlating more correctly this important section.

The rocks of Mississippian age, exposed beneath the Pennsylvanian in their area of extent in Western Kansas, vary from a residual chert section of Osage and older rocks, to beds of the youngest Mississippian (Chester series) which are found along the southern portion of the state from central Clark County westward. Their areal distribution is shown on the accompanying map.

The generalized section presented herewith is the writer's own and is an attempt to more correctly delineate the time-rock relationship of the section, so as to correct what the writer believes to be earlier miscorrelations.

Three Lithographic Groups

CHESTERIAN SERIES. There has been no attempt to subdivide into its component formations the rocks assigned to this series. The lithology is variable and it is difficult to correlate any particular bed throughout the presently known areal extent of this series. Roughly, there appear to be three main lithologic groups developed.

In southwestern Meade and southeastern Seward counties the uppermost beds assigned to this series are a gray to buff, finely oolitic, slightly porous, extremely fossiliferous, limestone. It is characterized by fragments of the bryozoa Archimedes, which is indicative of Pitkin or youngest Chesterian. This is the producing zone in the Adams Ranch pool.

Below this is a section of variable thickness made up of gray, white, buff, and light brown finely crystalline, very finely sandy, dense limestones with interbedded shales of varying shades of gray, green and maroon, some slightly sandy, with occasional lenses of fine angular sand.

The lower part is predominantly shaly with maroon and green shales predominating, interbedded with thin dense light colored finely sandy limes and beds of fine white angular sand. In some of the wells the basal Chester is a distinctive purple clay shale; in others, very fine, crystalline, dense, finely sandy limes which are difficult to differentiate from the underlying Ste. Genevieve.

In the southwestern part of the state in Morton County, the lowermost Chesterian beds are a red, very finely sandy, silty dolomite, or dolomitic sand. This section is well developed in Eason No. 1 Craver, Emergency Export No. 1 Interstate Cattlemen's Association, and in the Keyes Dome area of Cimarron County, Oklahoma. In the Emergency Export well, this red sandy section is overlain by light gray to buff, finely crystalline dense limestone. In the Eason No. 1 Craver, the red section was at the top and no data as to its thickness is available. It is absent to the north and east. The writer believes this to be the oldest Chester found in the area.

Upper Beds Vary

Throughout the remaining area of Chesterian rocks the uppermost beds penetrated vary from well to well, and the lithology encountered is apparently dependent on the thickness of the section found in the particular well. Where the total thickness of Chester has been penetrated it varies from 30 to 379 feet.

MERAMECIAN SERIES. The Meramecian is divided into four formations —Ste. Genevieve at the top, St. Louis, Spergen and Warsaw at the base.

Ste. Genevieve Formation: The Ste. Genevieve formation is composed of white to buff and light brown finely sandy, finely oolitic, non-porous limestone. The distinctive characteristics that separate these beds from the overlying fine sandy limes of the Chester are the very tiny oolites which are elliptical rather than round and are always darker in color than the containing matrix. It has been the writer's practice to call the top of the Ste. Gene-

vieve on the first appearance of these distinctive oolites.

The cherts of the Ste. Genevieve are sparse, but when present are generally milky, vitreous and semi-opaque to opaque in character. The thickness of this formation varies from 91 to 243 feet where overlain by Chester beds.

Many Criteria

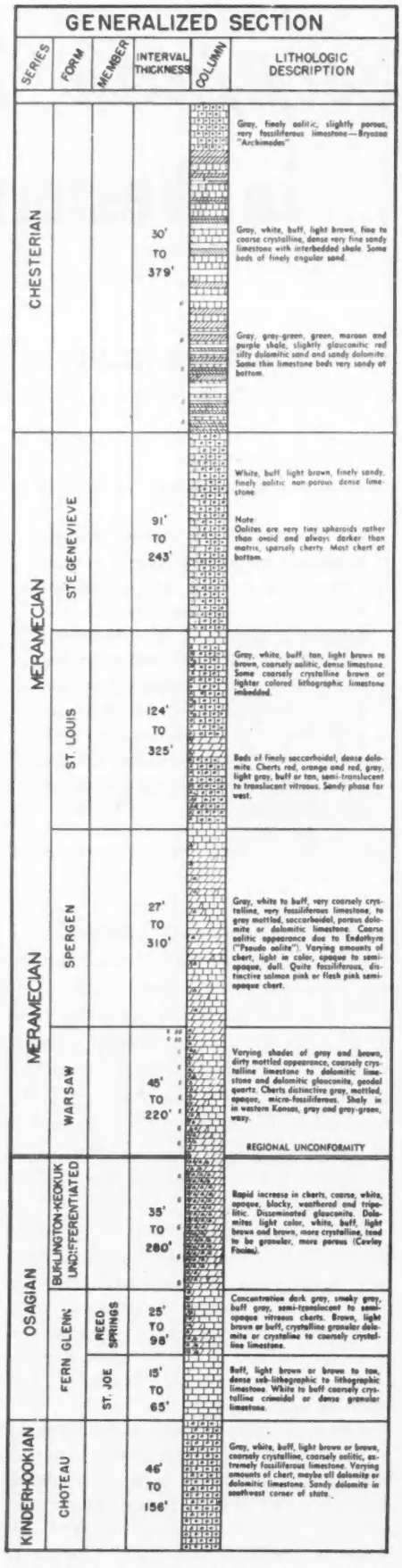
St. Louis Formation: The St. Louis formation displays the most varied lithology of any in the Mississippian section; consequently the criteria for its recognition are numerous.

In general it is light in color, varying from shades of gray through white, buff, tan or shades of brown. It may be a coarsely crystalline, coarsely oolitic, dense limestone, a coarsely crystalline dense, very fossiliferous limestone, a dense, dark brown, or lighter colored lithographic limestone, a finely sandy, finely oolitic limestone, and even occasionally contains beds of fine saccarhoidal, dense dolomite.

Where it is a coarsely oolitic, dense limestone, the oolites are very large and perfectly round in a dense matrix; where the matrix is coarsely crystalline there is generally an abundance of large free oolites in the samples. The dark brown lithographic limestone is one of the formation's most diagnostic features and it is found in no other part of the Mississippian except in the St. Joe limestone, and its stratigraphic position serves in that case as a protection for this criteria. The lithographic limestone is almost always found interbedded with whatever other lithologic facies is developed in the St. Louis. Where the St. Louis is a finely sandy, finely oolitic limestone, the diagnostic feature which differentiates it from the Ste. Genevieve is the fact that the oolites are almost always the same color as the matrix and are perfectly spherical, like tiny baseballs. Invariably, there are thin beds of dense brown lithographic limestone occurring with this sandy oolitic phase, a characteristic not displayed by the overlying Ste. Genevieve.

The St. Louis is often quite cherty and the cherts are likewise variable. The most distinctive is a red or orange-red, semi-transluscent, very vitreous chert. (An exceptionally fine development of this time is found in the Hartnett No. 1, Section 8-25-27w, Gray County, drilled by the Skelly Oil Company.) Other cherts in the St. Louis are gray, light gray, buff or tan in color, and are generally semi-opaque to semi-transluscent and vitreous.

The St. Louis varies in thickness from 124 feet to 325 feet but will have a fair average thickness of 150 feet where it is beneath younger beds. It is the producing horizon in the Shallow Water and Nunn pools of Scott and Finney counties.


GENERALIZED SECTION
SERIES
FORM
MEMBER
INTERVAL THICKNESS
COLUMN
LITHOLOGIC DESCRIPTION
CHESTERIAN
30' TO 379'
Gray, finely oolitic, slightly porous, very fossiliferous limestone—Bryozoa "Archimedes"
Gray, white, buff, light brown, fine to coarse crystalline, dense very fine sandy limestone with interbedded shale. Some beds of finely angular sand.
Gray, gray-green, green, maroon and purple shale, slightly glauconitic red silty dolomitic sand and sandy dolomite. Some thin limestone beds very sandy at bottom.
MERAMECIAN
STE GENEVIEVE
91' TO 243'
White, buff, light brown, finely sandy, finely oolitic non-porous dense limestone
Note: Oolites are very tiny spheroids rather than ovoid and always darker than matrix, sparsely cherty. Most chert at bottom.
ST. LOUIS
124' TO 325'
Gray, white, buff, tan, light brown to brown, coarsely oolitic, dense limestone. Some coarsely crystalline brown or lighter colored lithographic limestone imbedded.
Beds of finely saccarhoidal, dense dolomite. Cherts red, orange and red, gray, light gray, buff or tan, semi-translucent to translucent vitreous. Sandy phase far west.
SPERGEN
27' TO 310'
Gray, white to buff, very coarsely crystalline, very fossiliferous limestone, to gray mottled, saccarhoidal, porous dolomite or dolomitic limestone. Coarse oolitic appearance due to Endothyra ("Pseudo oolite"). Varying amounts of chert, light in color, opaque to semi-opaque, dull. Quite fossiliferous, distinctive salmon pink or flesh pink semi-opaque chert.
WARSAW
45' TO 220'
Varying shades of gray and brown, dirty mottled appearance, coarsely crystalline limestone to dolomitic limestone and dolomitic glauconite, geodal quartz. Cherts distinctive gray, mottled, opaque, micro-fossiliferous. Shaly in western Kansas, gray and gray-green, waxy.
REGIONAL UNCONFORMITY
OSAGIAN
BURLINGTON-KEOKUK UNDIFFERENTIATED
35' TO 280'
Rapid increase in cherts, coarse, white, opaque, blocky, weathered and tripolitic. Disseminated glauconite. Dolomites light color, white, buff, light brown and brown, more crystalline, tend to be granular, more porous (Cowley Facies).
FERN GLENN
REED SPRINGS
25' TO 98'
Concentration dark gray, smoky gray, buff gray, semi-translucent to semi-opaque vitreous cherts. Brown, light brown or buff, crystalline granular dolomite or crystalline to coarsely crystalline limestone.
ST. JOE
15' TO 65'
Buff, light brown or brown to tan, dense sub-lithographic to lithographic limestone. White to buff coarsely crystalline crinoidal or dense granular limestone.
KINDERHOOKIAN
CHOTEAU
46' TO 156'
Gray, white, buff, light brown or brown, coarsely crystalline, coarsely oolitic, extremely fossiliferous limestone. Varying amounts of chert, maybe all dolomite or dolomitic limestone. Sandy dolomite in southwest corner of state.

Generalized section of Mississippian rocks in Western Kansas.

Spergen Formation: Like the overlying St. Louis, the Spergen formation is quite varied in its lithology, although not quite so pronounced. It varies from a gray, white to buff, very coarsely crystalline, very fossiliferous limestone to a gray mottled, finely saccarhoidal, porous dolomite or very dolomitic limestone, Where it is a pure coarsely crystalline limestone it has often been logged as a coarsely oolitic limestone, which it certainly appears to be. However, close examination will generally show that the coarse oolites are actually a myriad of rotaloid foraminifera of the genus Endothyra, specifically Endothyra baileyii. It has been the writer's experience that in every instance where the Spergen is not a dolomitic lime or dolomite, that Endothyra baileyii is present to a greater or lesser extent. The Spergen is called a pseudo-oolitic limestone in its type locality because of this fact. This is an excellent index fossil for the Spergen and seems to be the best fossil criteria found in the Mississippian. Dolomitization destroys the fossil evidence though its previous presence can often be seen in the shape of the pores left in the dolomite. The Spergen contains varying amounts of chert, and in some wells it has been quite cherty. The cherts are generally light in color, often are fossiliferous, tend to be opaque to semi-opaque and are dull rather than vitreous. A most distinctive Spergen chert is a salmon pink or flesh pink, semi-opaque dull chert, which is sparsely developed in Western Kansas, though a very diagnostic criteria for this formation in eastern Kansas.

Thickness

The Spergen is variable in thickness. In the northwestern part of the state it is thin even when overlain by younger beds. From this area it thickens to the south and southeast, reaching its maximum thickness in western Meade County. It varies from 27 to 310 feet but will average almost 100 feet over most of western Kansas. The developed porosity due to dolomitization makes the Spergen an excellent reservoir bed, and it is the producing formation in the Arnold, Aldrich, Kansada and Manteno pools in Ness County.

Warsaw Formation: The Warsaw, like the Spergen above, varies from a coarsely crystalline limestone to a dolomite or dolomitic lime. Where both are dolomitic the contact between the two is a difficult one to determine in the samples. The limestones, dolomites and dolomitic limes of the Warsaw tend to be darker and range through varying

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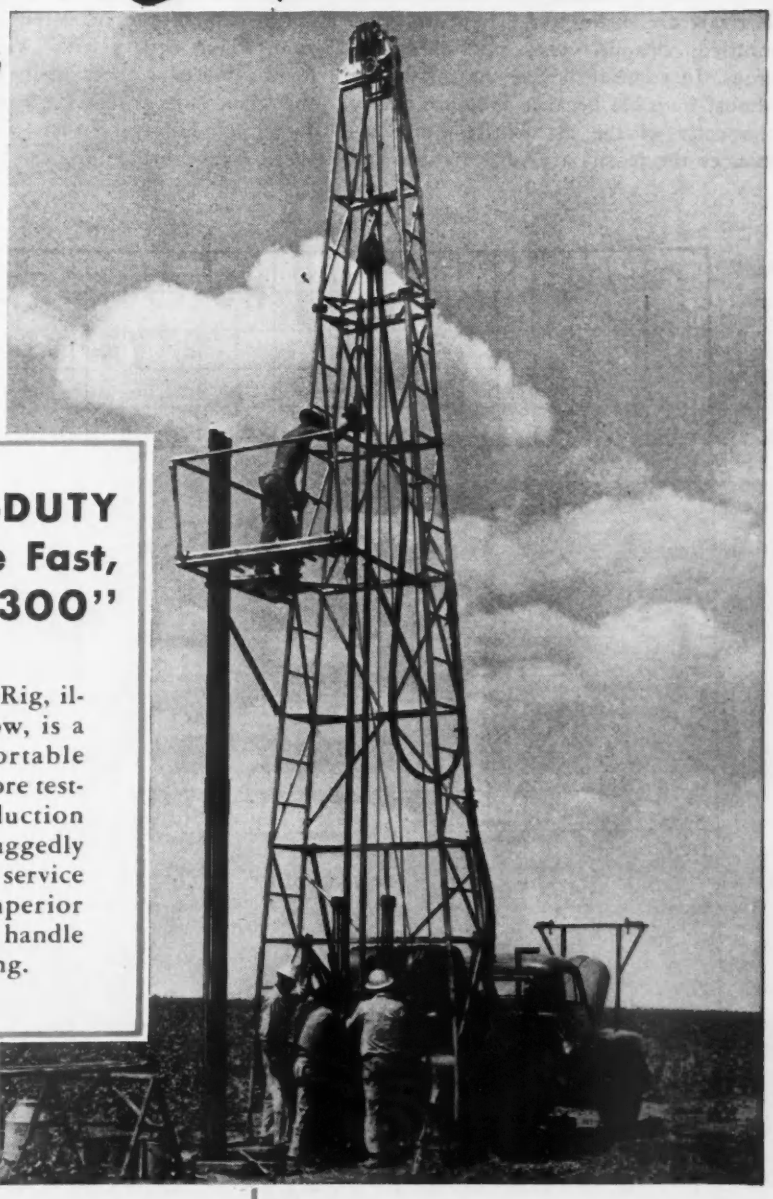

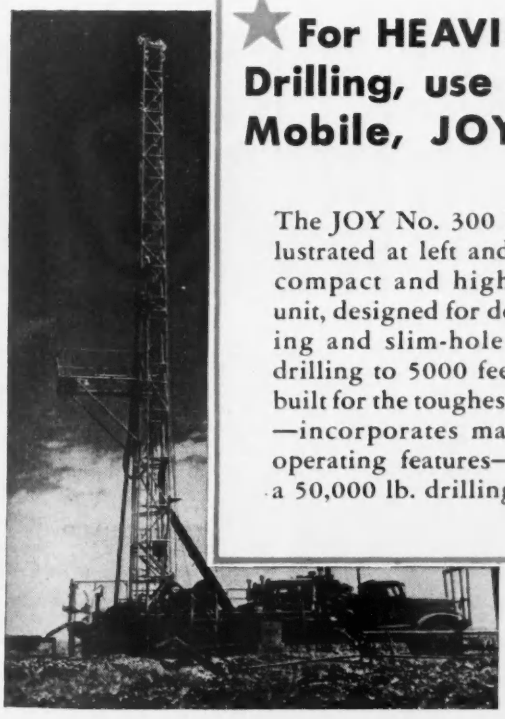

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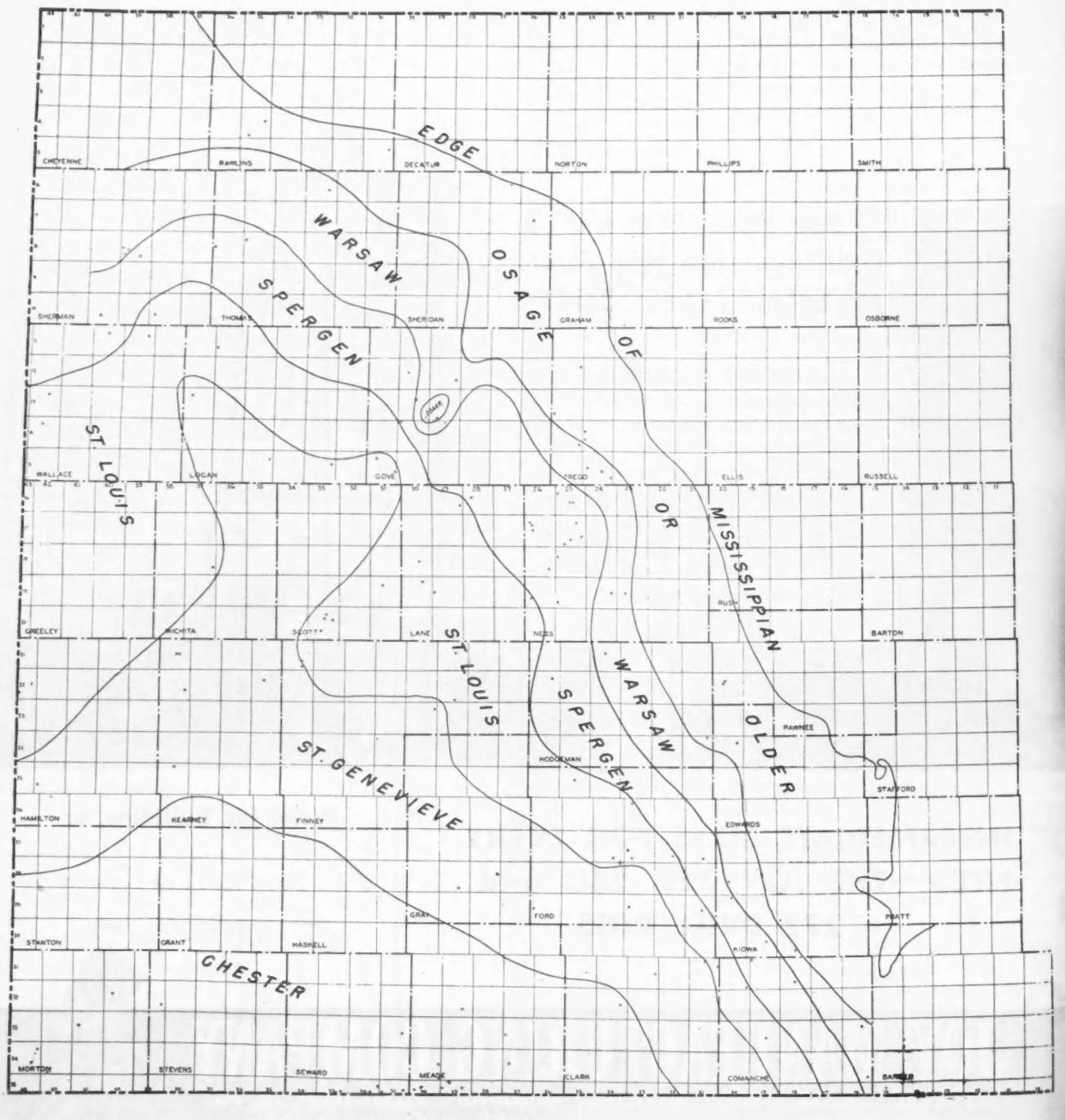
shades of gray and brown with a dirty, mottled appearance, caused either by black fossil inclusions or, in some instances, by minutely disseminated crystals of sphalerite. However, sphalerite is nearly always found in the chert, and to the writer's definite knowledge, has been found in only two wells in the dolomite. The dolomites and dolomitic limes are finely saccarhoidal and seldom show much porosity. The cherts of the Warsaw are distinctive. They are gray, mottled, opaque, very micro-fossiliferous. In some instances the fossils are almost invisible because they are nearly the color of the matrix. In other instances the fossils are very distinct and it is this type of chert which is most often associated with the Cowley facies, a character displayed by the Warsaw in the southern and eastern part of the deeper Mississippian Basin eastward from Clark County. Disseminated grains of glauconite are another diagnostic characteristic of the Warsaw, and they are found both in the dolomites and in the cherts. It has been the practice of the writer to call the top of the Warsaw at the top of the persistent glauconite zone which occurs with Warsaw sediments, unless as occasionally is the case, the glauconite is absent from the top. Generally, however, when this happens there is an abrupt increase in the percentage of chert or the appearance of clear to milky, geodal quartz fragments or quartz crystals, both of which criteria are indicative of the Warsaw. The latter mentioned occurrence is of considerable interest inasmuch as masses of quartz-filled geodes occur in the top of the Harrodsburg Limestone of Indiana and Illinois. This is the correlative of the Warsaw of the Missouri and Kansas section.

In some areas of Western Kansas the Warsaw becomes quite shally, in which case the shales are generally gray and gray-green and rather waxy. This shaly characteristic is not unexpected inasmuch as it is characteristic of the War-



Areal distribution of subsurface Mississippian in Western Kansas.

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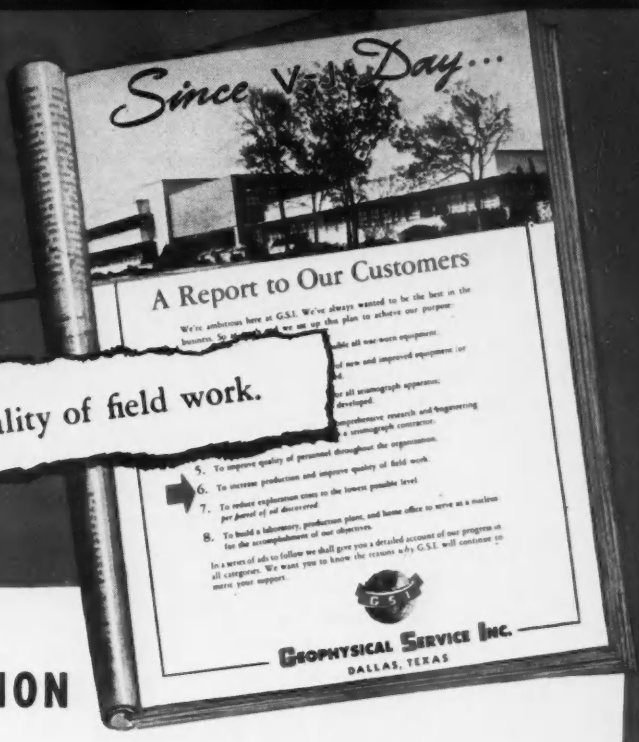
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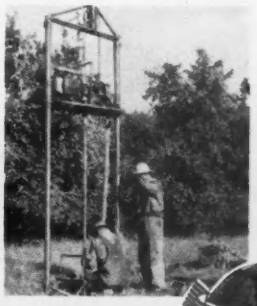

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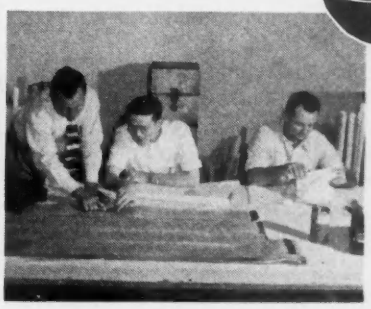

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saw in its type area. The shaly characteristic is well developed in the Skelly No. 1 Hartnett in Section 8-25-27w, Gray County.

The Warsaw ranges in thickness from 45 to 220 feet but will average about 70 feet over most of western Kansas.

OSAGIAN SERIES. Burlington-Keokuk Formation (Undifferentiated): The top of the Burlington-Keokuk, or probably as it is better known, the top of the Osage, is probably the most distinctive horizon in the Mississippian section. It is invariably marked by a rapid increase in the percentage of chert in the samples, and the chert is quite distinctive from the overlying dark, opaque, mottled, fossiliferous cherts of the Warsaw. The cherts of the Burlington-Keokuk are coarse, white, opaque, blocky, most generally highly weathered and tripolitic. This weathered chert is the principal evidence of the magnitude of the unconformity which occurred at the close of the Osagian time and makes a most distinctive marker. The dolomites of the Burlington-Keokuk are generally light in color, another distinct contrast to the overlying Warsaw. They vary from white to buff, light brown and brown, are more crystalline, tend to be granular rather than saccarhoidal, and have more porosity. However, they form a rather minor portion of the formation. The Burlington-Keokuk also contains disseminated glauconite, but it tends to be massive rather than granular and generally it is less well developed than in the overlying Warsaw. The thickness of the upper part of the Osagian is very variable because of the unconformity involved. It is very thin in higher pre-Pennsylvanian areas and thicker in the basins. It varies from 35 to 280 feet but will average close to 100 feet in thickness.

Cowley Facies: The upper Osagian displays another lithologic feature which is rather confusing when first observed. In the area along the Kansas-Oklahoma line westward from Cowley County and reaching as far north as Township 31 south, the typical light dolomites and white weathered, tripolitic and blocky cherts are replaced by a section of dark gray, drab, silty, shaly, dirty, finely crystalline dolomites, with dark gray, mottled opaque, fossiliferous cherts—Wallace Lee's "Cowley Formation."

It is the writer's opinion, however, that the Cowley is a basin facies deposit. This basin probably originated early in Kinderhookian time and received continuous deposition well up into the lower Meramecian, for, as mentioned previously under the Warsaw formation, this characteristic carries well up into the Warsaw. Further, it extends to the base of the Mississippian limestone section and probably to the base of the Mississippian, as much of the Woodford formation of the adjoining portion of Oklahoma is of this character. Where this facies occurs it is almost impossible to pick the Warsaw-Osage, or the Osage-Fern Glenn or Osage - Chouteau contacts.

Distinct Breaks

Fern Glenn Formation: Over much of Western Kansas, occurring between the white cherts and dolomites of the Burlington-Keokuk and the coarsely crystalline limestone at the base of the Mississippian limestone section are two distinct breaks. These have been correlated by the writer with the Reed Springs and St. Joe members of the Fern Glenn formation of the lower Osage of the Missouri type section. Presence of both of these members in the same well is limited to the Dodge City arm of the Anadarko Basin as it has been more recently designated by John Maher of the U. S. Geological Survey, "The Hugoton Embayment"[1] roughly south of Township 25 south in the eastern portion and south of Township 22 south in the extreme west.

Reed Springs Member: The Reed Springs is characterized by a concentration of dark gray, smoky-gray and blue-gray, semi-transluscent to semi-opaque, vitreous cherts. Associated with the cherts is generally a brown, light brown or buff, crystalline, granular dolomite or crystalline to coarsely crystalline, often fossiliferous, limestone. To the north of the above mentioned basin only the Reed Springs member is found east of a line roughly drawn along Range 31 west, particularly in Western Ness, Gove, Lane and Eastern Scott counties. It varies from 25 to 98 feet but will average close to 25 feet in thickness in most of its occurrences.

St. Joe Member: The St. Joe is most often a buff, light brown, brown, dark brown, red or varying shades of tan, dense, sub-lithographic to lithographic limestone. From this it varies to a white or buff dense granular limestone or a white coarsely crystalline crinoidal limestone. Infrequently it has been observed that the beds attributable to this member are completely dolomitized, but where this has occurred the dolomite is very dense and dark in color. In addition to its occurrence in the basin mentioned above with the overlying Reed Springs, it is present by itself in most of the wells west of Range 31 west and north of Township 22 south.

The St. Joe varies from 15 feet to a maximum of 65 feet, but will average 35 feet in thickness in most of its occurrence in Western Kansas.

KINDERHOOKIAN SERIES. Chouteau Formation: The lowest limestone in the Mississippian in Western Kansas is a coarsely crystalline, coarsely oolitic, and extremely fossiliferous limestone. The use of the term Chouteau by the writer is in part an arbitrary device to get away from the use of the term "Gilmore City" to denote the basal Mississippian, and in part to indicate the writer's belief that this basal section is correlative in age and time of deposition to the Northview Shale and Compton Limestone. It is the writer's belief that it is properly used to denote this basal section. The Chouteau, in addition to its coarsely oolitic phase, is sometimes entirely dolomitic, or displays variations of dolomitic limestone, both cherty and non-cherty, or is a crystalline, dense, sparsely cherty limestone. In color the Chouteau is gray, white to buff, light brown, or brown and it carries these colors through the varying lithologic phases it displays. The cherts are varying shades of gray to brown and are often fossiliferous and generally opaque. One distinctive chert is a dark blue-gray, opaque, stippled, dead chert, but it is not widely developed in Western Kansas. Its stratigraphic position and regular thickness are other criteria for its correct delineation.

It varies in thickness from 46 to 156 feet, having its greatest development in a rather limited area in Northwest Gove, Southeast Thomas, and Northeast Logan counties. It will average about 100 feet in most of the wells except in the above mentioned area.

In conclusion, it is well to point out that where samples are good, most of the formations show some slight indication of unconformity. This is shown by the presence of weathered chert, concentrations of fine angular to round sands, either free or imbedded in pale turquoise green, waxy shales, and by other conglomeratic materials. Likewise, the breaks show plainly on the electric logs and these are most helpful in dividing the Mississippian into its component parts.

REFERENCE

[1] Maher, John C., and Collins, Jack B., "Hugoton Embayment of Anadarko Basin, in Southwestern Kansas, Southeastern Colorado, and Oklahoma Panhandle," in AAPG Bulletin, Vol. 32, No. 5 (May, 1948) pp. 813-819.

ACKNOWLEDGMENT

The writer wishes to thank the Kansas Geological Society for permission to publish this paper. Copies of the complete report and the large scale map are available at the Kansas Well Log Bureau, Wichita, Kansas, price $1.

Oil and Gas Exploration in the *Four Corners Area* of Arizona, Colorado, New Mexico and Utah

By J. L. TATUM
Independent Geologist, Durango, Colo.

THE "FOUR CORNERS" area of Arizona, Colorado, New Mexico, and Utah, extending about 125 miles in all directions from the common corner of the four states, includes the San Juan Basin, the Black Mesa Basin, the Paradox Salt Basin, and the Colorado Platform. This area is as large as West Texas and is expected to become eventually an important oil producing province. The San Juan Basin portion already is showing for important gas reserves in its shallower horizons. The district has had fewer wells drilled to prospective productive horizons than the Permian platform had 25 years ago.

THE "Four Corners" area of Arizona, Colorado, New Mexico, and Utah, now being actively explored as a unit, extends roughly 125 miles in all directions from the common corner of the four states. The towns of Durango, Colo.; and Farmington and Albuquerque, N. M., are regional headquarters for practically all the companies operating in it. Most have headquarters in Durango.

It has been divided into the following structural provinces, all of which have formations of the same ages and with some exceptions to be mentioned later, the same stratigraphic characteristics: The San Juan Basin, the Black Mesa Basin with an arm into Utah known as the Kaiparowits Basin, the Paradox Salt Basin (also known as the Colorado-Utah Salt Basin) and the Colorado Platform. None of these basins is sharply outlined and all grade into the Colorado Platform which occupies intervening areas.

Oil History

The first recorded oil excitement of the area was the result of the discovery of live oil seeps on the San Juan River near Mexican Hat in 1879 by E. F. Goodridge, who filed claims and on March 4, 1908, struck oil at a depth of 225 feet which flowed over the derrick. A large number of shallow wells were drilled but they were short-lived. Since that time many widely scattered seeps have been found which frequently resulted in the drilling of shallow wells by local people. In the early 1920's extensive geological examination of the area was made by several of the large companies, and a number of shallow wells were drilled. Most of the present oil and gas fields in the San Juan Basin were found at that time. There were few deep wells drilled, even for the depths common during that period. Because of the era of overproduction in places more accessible to the large markets, the area was practically abandoned by the large companies except for the small production to supply a limited local market. During this period the entire Rocky Mountain region was also dormant except for enough drilling to supply the local markets.

With the building of a gas line to Albuquerque and other towns of the Upper Rio Grande a fairly large area had been proven for gas in the Upper Cretaceous beds in the Farmington-Blanco-Kutz Canyon area. Most of the Upper Cretaceous gas is non-structural and although most of the wells are under 5 million feet, the producing areas are continually being extended and may cover a very large area. Very large gas wells have been completed in the past few years in the Paradox section of the Hermosa on the Barker Creek Dome. The limits of the Barker Creek have not yet been defined, and the reserves are believed to be very large.

An active leasing campaign was started in 1945 and 1946, led by Byrd-Frost and Stanolind Oil & Gas Company. Since that time most of the large companies have put exploration parties in the field, and most of them have taken

About the Author

J. L. TATUM, independent geologist, Durango, Colo., has done geological work in Mexico as well as in various parts of the U. S. and has been engaged in work in the "Four Corners" area of the Rocky Mountain region in recent years. He was born December 27, 1896, in Woodbury, Tenn. He received a B. A. degree in geology at Oklahoma University in 1919. He was chief geologist for Marland (Continental) Oil Company of Mexico in the years 1925-1934, and was chief geologist for Plymouth Oil Company in the period 1935-1945. From 1945 to the present time he has been an independent geologist.

large blocks of leases. A drilling program was started by Byrd-Frost and Western Natural Gas Company in 1948 which has resulted in the discovery of gas and oil at Kutz Canyon in the Dakota of Cretaceous age and of gas in the Pennsylvanian and oil in the Permian at Boundary Butte and gas and distillate in the Pennsylvanian at Dove Creek, Colorado. The California Company discovered oil in the Pennsylvanian at Upper Valley in the Kaiparowits Basin in 1948. This well was still testing recently.

Amerada Petroleum Corporation had some very high pressure gas in the Pennsylvanian at Green River, and because of the condition of the hole, had to cement and abandon. The company is drilling a second well in this area.

Geologic Section

The cross-section by the U. S. Geological Survey entitled preliminary Chart 7 shows graphically the Paleozoic rocks of the Colorado Platform and of the Paradox Salt Basin as known at the time of the publication of the chart. Since this chart was published, a thin section of Middle Upper Ordovician dolomite with some Simpson type sand was found in Boundary Butte. Other cross-sections listed in the bibliography have been published by the Geological Survey showing the Paleozoic section along the eastern edge of the San Juan Basin and the southern edge of the Black Mesa Basin. No wells have been drilled far enough in the above mentioned basins to explore the Paleozoic section within the basin proper. Most paleogeographers show the Ordovician as not having been deposited over this area. However, the occurrence of a thin Ordovician section at Boundary Butte and its probable appearance in central Utah makes it seem probable that it will most likely be present in the Black Mesa Basin and Paradox Salt Basin and it is entirely possible that it may be present in the deeper portions of the San Juan Basin.

The Devonian, where known in the mountains and in a few wells on the platform, is dolomitic, cavernous on its outcrop, and has quite frequently had shows. Only about 200 feet is known but at least a portion of the top has been removed by erosion and it seems most probable that a more complete Devonian section should be found in the basins. The top of the Mississippian also has been eroded where known and more of it should also be present in the basin.

The Molas, which is the basal member of the Pennsylvanian, as known in the nearby mountains and in wells on the platform, is thin and has an eroded upper limit. The Paradox member of the Hermosa is not positively known to outcrop except where it is extruded in salt anticlines in the Paradox Salt Basin.

TABLE 1
Geologic Formations in Northwestern New Mexico
Bureau of Mines and Mineral Resources

Age	Formation		
Pleistocene			
Pliocene			
Miocene			
Oligocene			
Eocene	Chuska ss. 700–900	Wasatch fm. 1000	
	Tohatchi sh. 200–1100	Torrejon fm. 275	
		Puerco fm. 1200±	
	Ojo Alamo ss 0–400		
	McDermott fm. 0–400		
Upper Cretaceous	Kirtland sh. 700–1180	Farmington ss. member 0–480	
	Fruitland fm. 190–530		
	Pictured Cliffs ss. 50–275		
	Lewis sh. 75–2290		
	Mesaverde Group	Cliff House ss. 0–1076	
		Menefee fm. 272–1200	
		Point Lookout ss. 60–300	
	Mancos sh. 750–2000	Tocito ss. lentil 0–35	
	Dakota ss. 50-250		
Lower Cretaceous (Comanchean)			
Jurassic	Morrison fm. 300–600		
	San Rafael Group	Entrada fm.	0–40
		Carmel fm.	
	Glen Canyon Group	Navajo ss. 100	
		Kayenta ss. 40	
		Todilto fm. 0–100	
		Wingate ss. 300	
Triassic	Chinle fm. 1575		
	(Shinarump ?)		
	(Moenkopi ?)		
Permian			
	*Coconino (?) ss. 150		
	*Cutler fm. 1410		
		San Andres ls. 110	
		Glorieta ss. 285	
		Yeso fm. 900	
		Abo fm. 600–700	
Pennsylvanian	*Virgil series		1550±
	*Missouri series		
	*Des Moines series		
	*Derry series		
Mississippian	*Ls. and dolomite 215		
Devonian	*Sh. ls., and dol. 140		
Silurian			
Ordovician			
Cambrian	*Ignacio quartzite 2+		
Pre-Cambrian	Granite and schist		

* Penetrated in Continental Oil Co. No. 100 Navajo, 7,407-foot test in Rattlesnake pool, San Juan County.

Likewise, its thickness is unknown. Recently the American Liberty Oil Company drilled a well on the Paradox Anticline below 10,000 feet, starting and ending in this formation. It was evident, however, that at least a large portion of it had been intruded by flowage, and it was not known at this time whether the thickness of this formation as deposited is this great. It probably is not. The entire Hermosa formation is marine wherever found and quite variable as shown by the various published cross-sections. It produced oil in Rattlesnake, gas at Barker Creek and Boundary Butte, gas and distillate at Dove Creek, and oil at Mexican Hat. Most wells drilled through it have had shows of oil and gas and it seems most likely that commercial production should be found in it both in the basins and on the Colorado platform.

The age of the Rico formation, which lithologically grades both into the marine Hermosa below and non-marine Cutler above, is still undetermined. It is usually assigned questionably to the Permian. The Permian is at least in part marine in the Grand Canyon area and there is probably a marine stringer of Coconino sandstone of Permian age at Boundary Butte, where some shallow oil production has been developed in it. It seems reasonably certain that it will be at least in part marine in the Black Mesa Basin. It is known to be part marine in the western portion of the Paradox Salt Basin, and there should be marine members in the synclines between the large salt anticlines in that basin. It is questionable as to whether or not marine Permian will be found in the San Juan Basin, although it is certainly possible that it may be.

The Triassic, where known, is almost entirely made up of red beds. However, there are some thin fossiliferous marine beds in the Paradox Salt Basin and small quantities of oil have been found in it in nearby areas. It could produce oil commercially.

The Jurassic is, like the Triassic, largely red beds, although some gypsum and a few thin limestones are known to occur in it. Dead oil has been found in the Entrada member of the Jurassic in the wells in the eastern portion of the San Juan Basin and on its outcrop along the Piedra River.

Only the Upper Cretaceous is present in the area, and it is almost entirely marine. The lower member, the Dakota sandstone, produces both oil and gas on the platform along the northwest rim of the San Juan Basin, and it produced oil and gas in a single well at Kutz Canyon within the San Juan Basin, and has gas in the Rosa well of the Stanolind in this basin. The Mesaverde group produces gas in the San Juan Basin, and there is one

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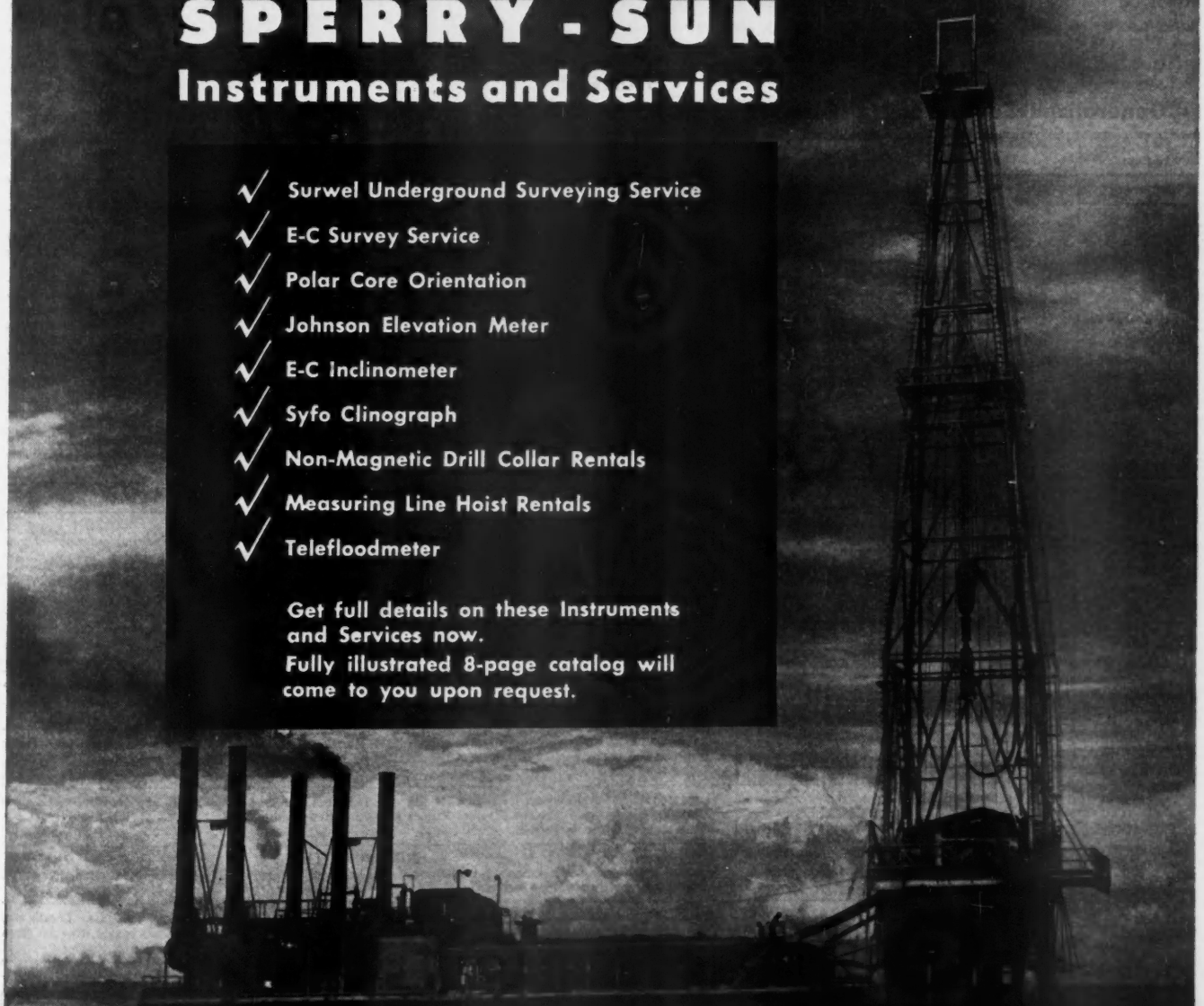

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small but profitable oil field producing from it near the southern rim of the San Juan Basin.

The Tertiary is entirely non-marine where known, and it occurs principally in the San Juan Basin, and is not now thought to be promising for oil and gas.

Structural Provinces

The various structural provinces are shown on Figure 1. Both the San Juan Basin and Black Mesa Basin are large saucer-like basins with comparatively flat-lying beds. The known structures in them are of low relief, more the type common to the Mid-Continent than those of the northern Rocky Mountain region.

The Paradox Salt Basin is unique in North America. Its shape suggests a deep-seated graben, probably tilted to the southeast. It is filled with very large steep-sided anticlines, most of which have salt and black shale of the Paradox extruded along the crest. The literature is voluminous as to the nature and history of these salt anticlines. The accompanying diagrams (Figure 2) by William Lee Stokes probably contain the most reasonable explanation of them. However, on the banks of the Dolores River as it leaves Gypsum Valley there is an angular eroded unconformity within the Hermosa, suggesting that these folds were being formed within Pennsylvanian time.

The Colorado Platform is a relatively

TABLE 2

Generalized Section of the Exposed Sedimentary Rocks of the Utah-Colorado Salt-dome Region

System	Series	Group or Formation		Lithologic Characters, Thickness, etc.
Quaternary				River and terrance gravel, dune sand, pediment cover, landslide debris, etc.
Cretaceous	Upper Cretaceous	Mesaverde Group		UNCONFORMITY Littoral, estuarine and brackish water sediments. Gray and yellow sandstone with interbedded gray shale. Lower part only is preserved in the region. Contains important coal beds in adjoining areas. Contains fossils of Late Cretaceous age. Incomplete thickness near Gypsum Valley about 500 feet.
		Mancos Shale		Slate-gray marine shale with a few lenses of yellow gray sandstone and light gray marl. The Ferron sandstone member occurs 450-500 feet above the base in the western part of the region, but is absent in eastern exposures Soft and easily eroded, forms badlands and graded slopes. Fossils of Late Cretaceous age are abundant especially near the base. Estimated total thickness—3,000 feet.
		Dakota Sandstone		Yellow sandstone, yellow and gray conglomeratic sandstone, gray shale and thin impure coal. Conglomerates contain pebbles of chert and quartzite. Forms cliffs and dip slopes. Contains plant remains of Late Cretaceous age. Thickness ranges from 5 to 200 feet.
	Lower Cretaceous (?)	Burro Canyon Formation		UNCONFORMITY Extremely variegated terrestrial sediments including varicolored shale, chert, limestone, conglomerate and sandstone. Lower conglomeratic member usually forms cliff and dip slope. Contact with Morrison obscure where basal conglomerate is absent. Fossils suggest but do not prove Early Cretaceous age. Thickness varies from 5 to 260 feet.
Jurassic	Upper Jurassic			UNCONFORMITY
		Morrison Formation		BRUSHY BASIN SHALE MEMBER: Varicolored bentonitic mudstone with minor lenses of sandstone, conglomerate, limestone and quartzite. Forms slopes and badlands. Silicified wood and dinosaur bones common. 350-450 feet. SALT WASH SANDSTONE MEMBER: Interbedded gray, medium-grained sandstone and red to gray sandy mudstone. Usually forms rough ledgy slope. A fluvial deposit. Locally gypsiferous at base. 250-350 feet. (Total Morrison 600-800 feet).
		San Rafael Group	Summerville Formation	Thin-bedded, red, chocolate-colored or gray siltstone, shale and sandstone. Usually calcareous. Locally contains large chert concretions and gypsum beds. Becomes progressively less evenly bedded eastward. Forms either either slopes or cliffs 35-200 feet.
			Curtis Formation	Greenish-gray sandstone, shaly sandstone and minor shale. Well-developed marine facies is present only in extreme western part of region. Disappears eastward by gradational changes into Summerville and Entrada formations. 0-200 feet.
			Entrada Sandstone	Silty, red siltstone with minor sandstone in western part; grades eastward into nearly pure massive sandstone. Partly aqueous and partly aeolian in origin. Characterized by large (1 mm) sand grains in massive portions. Locally called the "slick-rim." 100-450 ft.
			Carmel Formation	Variegated marine and non-marine sediments. Brown, pink, red, and gray sandy shales and mudstones in western part; grades eastward into red silty sandstones with contorted bedding. Locally absent. Where very thin, has been mapped with the Entrada. 0-150 feet.
	Jurassic (?)	Glen Canyon Group	Navajo Sandstone	UNCONFORMITY Massive, much cross-bedded, aeolian sandstone. Local lenses of dense gray limestone. Forms rounded cliffs and hummocky benches. Thins eastward and disappears near eastern margin of area. 0-550 feet.
			Kayenta Formation	Irregularly bedded, probably fluvial, micaceous sandstone and sandy shale. Red, gray, and lavender. Locally conglomeratic, contains poorly preserved fresh-water molluscs and plant fragments. Forms rough, irregular slope. 100-300 feet.
			Wingate Sandstone	Massive sandstone in thick horizontal beds with much fine cross-bedding within them. Weathers to vertical much-jointed brownish-red cliffs.
Triassic	Upper Triassic	Chinle Formation		Variegated shale and mudstone with minor lenses of sandstone, conglomerate, and limestone, Contains scattered fresh-water invertebrates, silicified wood and vertebrate bones. 100-700 feet.
	Middle or Upper Triassic	Shinarump Conglomerate		Conglomerate, conglomeratic sandstone, sandstone, and shale. Conglomerates contain lime-pellets, quartz, chert, etc. Silicified wood abundant. Forms rough cliffs and wide benches. 0-125 feet.
	Lower Triassic	Moenkopi Formation		Thin-bedded, much ripple-marked micaceous sandstone and siltstone. Chocolate-brown, red-brown and gray; locally gypsiferous. Contains thin fossiliferous marine bed in Green River area. Not recognized in extreme eastern part of region. 0-940 feet.
Permian		Cutler Formation		UNCONFORMITY A variegated unit consiting of non-marine sandstone, conglomerate, siltstone, and shale. In the western part several subdivisions are recognized; in ascending order these are the Cedar Mesa ss member, the Organ Rock tongue, and the White Rim sandstone member. In the Colorado section the formation contains more clastic material including much arkose. Strongly marked facies changes are characteristic. 400?-1700 feet.
		Rico Formation		Interbedded marine and non-marine sediments. Gray, red, reddish-purple sandstone, shale, and siltstone interbedded with gray to greenish-gray limestone. Fossils locally abundant. Contacts not well marked?.-585 feet.
Pennsylvanian		Hermosa Formation		Massive to thin-bedded, gray and bluish-gray fossiliferous, marine limestone; gray, greenish-gray, and green shale and white, gray and greenish sandstone. Exposed only in deeper canyons and around the margins of salt plugs where it is highly deformed and shattered. A complete section is probably not exposed in the area but well logs indicate the general nature and as a rule show a high proportion of limestone in the lower part. Contacts not well marked. 1800 plus feet.
		Paradox Formation (Some call this a member of Hermosa)		Formation outcrops only in much deformed and structurally complex areas in the form of gypsum masses. Shown by well logs to consist of common salt, gypsum, anhydrite, various potash and magnesium salts, black shale, and limestone. Total thickness not known but probably exceeds 3000 feet This is the formation which has, by plastic flow and solution, created the distinctive structures and topography of the salt-dome region.

NOTE: Since all formations older than Morrison thin and disappear over the crest of the salt plugs, it is obvious that they have zero thickness in places. In the above tabulation, this is not taken into account, a zero thickness means absence of the formation at places other than at the crest of the plugs.

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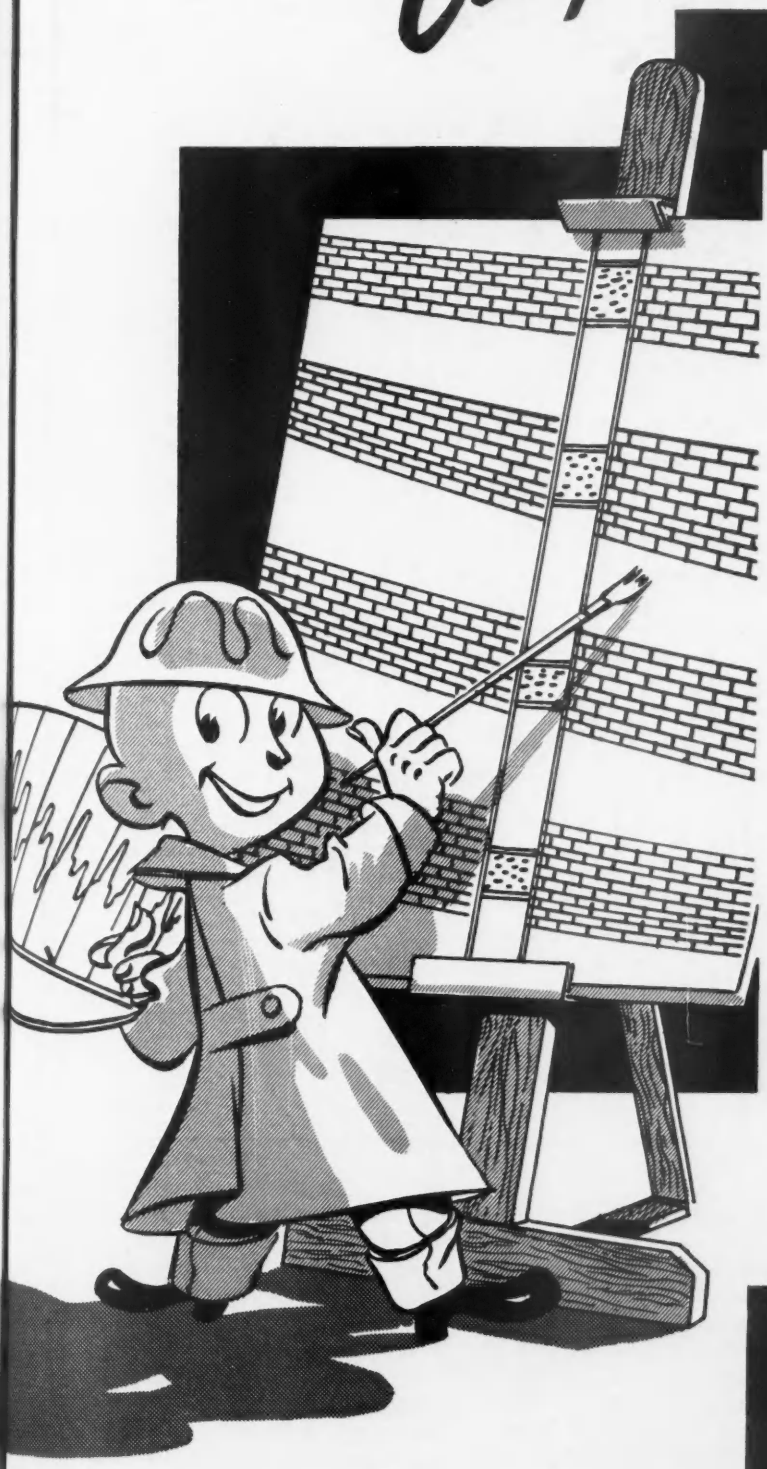

Even at best, core records and driller's logs show gaps—gateways to let in guesswork. But Lane-Wells Radioactivity Well Logging paints an accurate foot-by-foot picture, confirming core records and driller's logs, connecting them, filling in the gaps. It provides the information missed when no cores were taken, or when recovery was incomplete. It picks-up formations which the driller may not have logged, calls attention to possible production zones, and defines the characteristics, depths and extent of *all* formations with a pin point accuracy. And Radioactivity Well Logging works equally well *in open or cased hole!*

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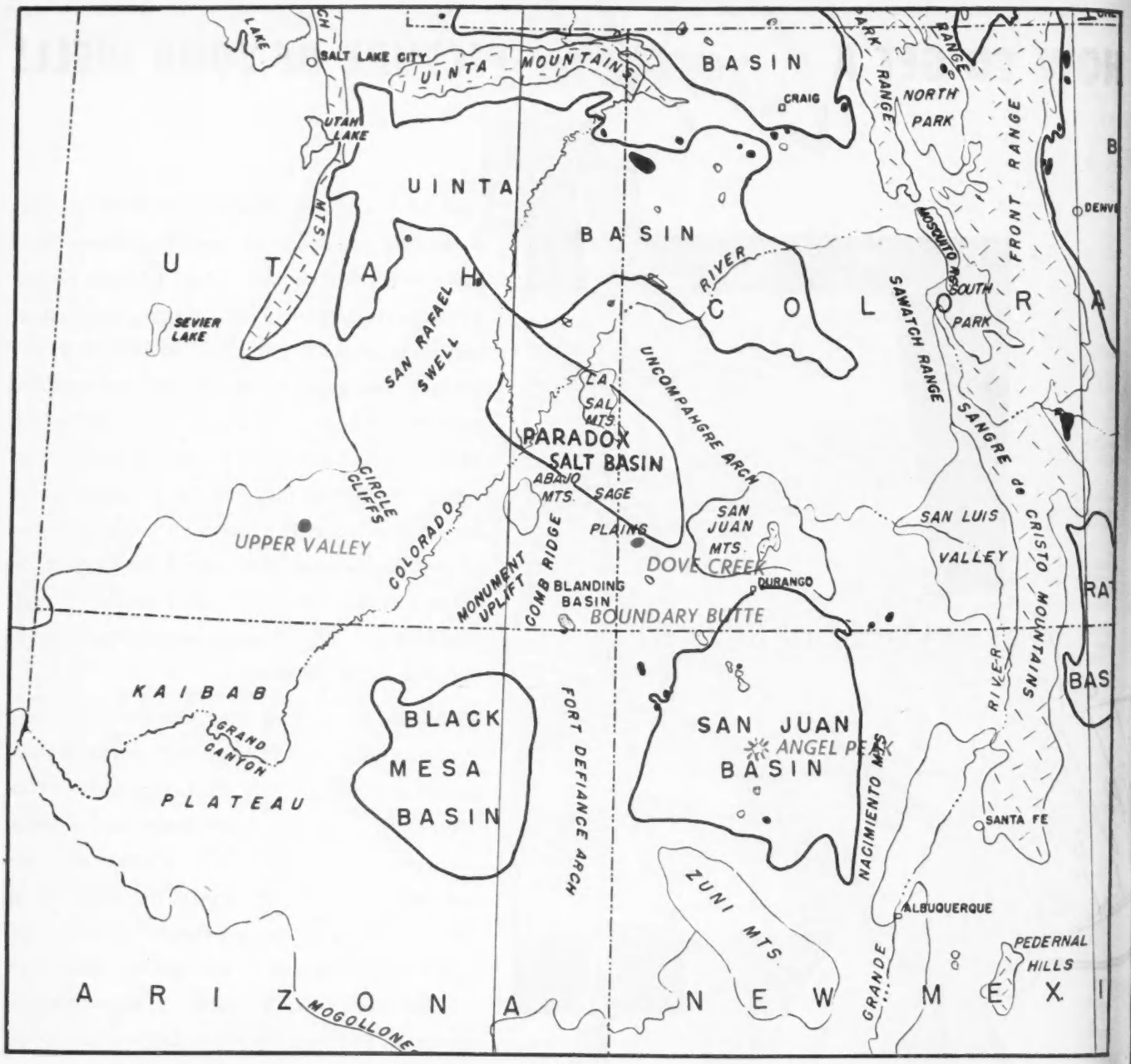

FIGURE 1

flat area with some large regional type structures occupying the area between the basins. The most prominent of these regional structures are the Monument Uplift, San Rafael Swell, and Circle Cliffs Anticline. These structures have been described in the literature and are regional in nature, some covering several hundred square miles,. All have had wells drilled on them, and the Paleozoic beds known to be on the platform are present over them and perhaps slightly thinner. Most wells drilled on them have had shows, although no commercial production has been developed to date. The Hogback, which forms the north and west rim of the San Juan Basin, is formed by beds dipping very steeply into the basin and has a number of relatively small structures, most of which produce oil and gas. The deposition history of the Paradox Basin seems to be remarkably similar to that of the Delaware Basin. The Dove Creek Structure is probably on a platform along its southwestern rim. Following the West Texas parallel, the platform along the rim of the Paradox Basin should be a natural location for reefing. There is some slight evidence of this reefing in the Dove Creek area, and in the few wells drilled, this consists of replacement of minute voids by calcite and gypsum in some of the limes of the Upper Paradox and Lower Hermosa.

Intensive Lease Play

All the known structures except those in the Indian reservations are solidly under lease. In addition, there has been an intensive lease play along the flanks of the Uncompahgre Uplift in which pinchouts are expected within the Paleozoic section. A similar play but to a less extent has been made along the east side of the San Juan Basin. In the past a large number of shallow wells have been drilled along the crest of the salt anticlines in the Paradox Basin, most of which have had shows and several have had blowouts. These crests are solidly under lease, with the hope that there was Pre-Paradox folding and that older beds may be productive under the Paradox. The flanks, also, of these anticlines have been leased, an the theory that there may be flank production such as is found on the flanks of piercement coastal salt domes and that there may be pinchouts of marine Permian and Pennsylvanian along their flanks, such as is expected along the flanks of the basin.

Strange to say, there have been no deep wells drilled on the flanks of the salt anticlines. There are a great number of structures of low relief both on the

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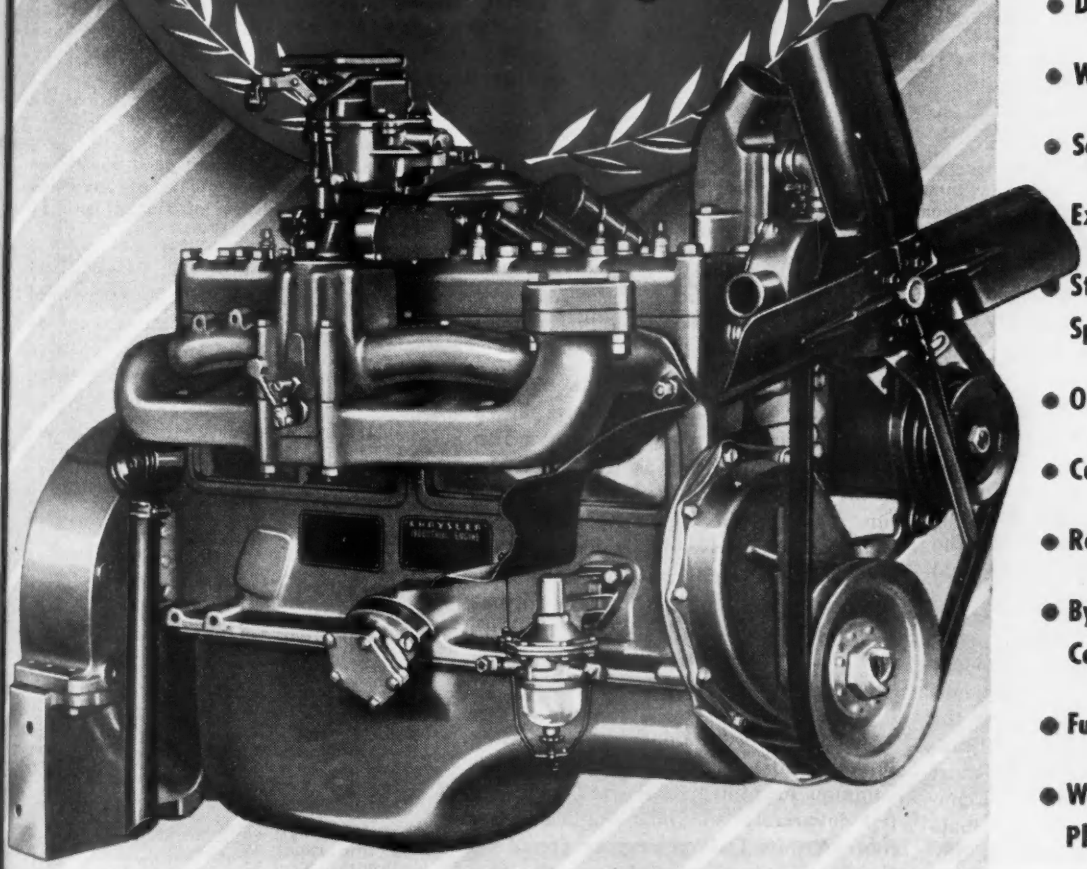

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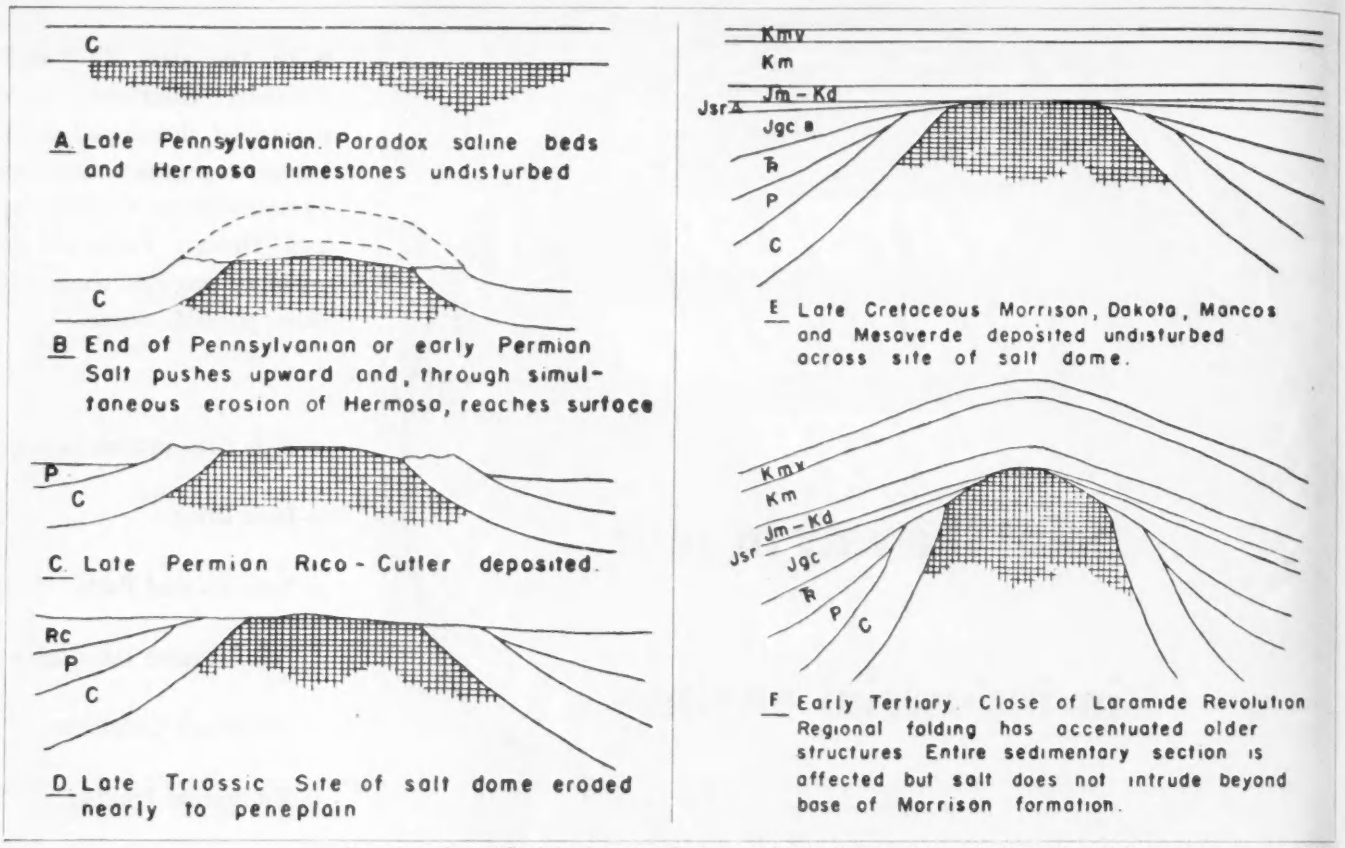
C
A Late Pennsylvanian. Paradox saline beds and Hermosa limestones undisturbed
C
B End of Pennsylvanian or early Permian Salt pushes upward and, through simultaneous erosion of Hermosa, reaches surface
P
C
C Late Permian Rico - Cutler deposited.
RC
P
C
D Late Triassic Site of salt dome eroded nearly to peneplain
Kmv
Km
Jm - Kd
Jsr
Jgc
Tr
P
C
E Late Cretaceous Morrison, Dakota, Mancos and Mesaverde deposited undisturbed across site of salt dome.
Kmv
Km
Jm - Kd
Jsr
Jgc
Tr
P
C
F Early Tertiary. Close of Laramide Revolution Regional folding has accentuated older structures Entire sedimentary section is affected but salt does not intrude beyond base of Morrison formation.

Drawings from "Guidebook to the Geology of Utah, Number 3," by William Lee Stokes, University of Utah.

FIGURE 2. Evolution of Gypsum Valley type salt structure. Vertical scale is greatly exaggerated; width of salt mass at highest point about three miles. (Cross-lined symbol indicaes Paradox formation; C. Hermosa fm.; P, Permian fms.; Tr, Triassic fms.; Jgc, Glen Canyon group; Jsr, San Rafael group; Jm-Kd, Morrison to Dakota fms.; Km, Mancos shale; Kmv, Mesaverde group.) Drawings from "Guidebooks to the Geology of Utah, Number 3," by William Lee Stokes, University of Utah.

platform and in the basin which are imperfectly known. These are now being mapped by surface parties and by various geophysical methods. Until quite recently, detailed surface work consisting of accurate plane table mapping has been neglected. Within the past few months a number of companies have put detail parties in the areas. Except for the areas covered by the Tertiary beds, detailed surface mapping should be the most economical and satisfactory method of exploration now available.

Area's Prospects

In the development of any new large area, the only certainty is the unexpected. The plateau area along the eastern and southern rims of the Paradox Basin now seems to be the most likely area for reefing within the Pennsylvanian. Small surface anomalies mapable only by detail work may be the guides for such reefing. The large Dove Creek Anticline, on which Byrd-Frost recently discovered a gas distillate well, deserves several widely spaced wells, as does McElmo Anticline. Some of the smaller structural features along the rims of the large regional uplifts now appear attractive. Marine Permian and Jurassic may occur on the flanks of the salt anticlines, as will the expected truncation of Hermosa beds. There should be more complete Mississippian and Devonian sections, especially in the deep basins, and beds of Ordovician age may also be present. These may be present and prove productive along the crest of the salt anticlines.

As already mentioned, beds mapped as Entrada of Jurassic age have shown dead oil in wells near the eastern rim of the San Juan Basin as well as on the surface in Piedra Valley along its north rim. Beds of this age have been neglected as prospective horizons. The two deep Dakota wells in the San Juan Basin made small wells, but the formation was hard and dense. The Dakota on the surface is usually friable but is locally silicified to quartzite. Some of these quartzitic areas are very limited in extent. This secondary mineralization both in sandstones and limestones is more common near structural axes, although not invariably so. This suggests that more porous Dakota may be found on the same structures and near the two discoveries mentioned.

The author believes that this area, which is as large as West Texas, will eventually become an important oil producing area. The San Juan Basin portion is already showing for important gas reserves in its shallower horizons. We have had fewer wells drilled to prospective productive horizons than had the Permian platform 25 years ago. The Pennsylvanian on the platform looks more attractive than it did in West Texas ten years ago with a much less density of wells. The wells drilled through the Pennsylvanian, except on the rims of the basin where the section was thin and incomplete can be counted on one's fingers. Most of these were on very large structural features which are on the order of geo-anticlines.

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The literature on the area is large and mostly by the United States Geological Survey. The following bulletins are of interest:

U.S.G.S. Bull. 806C
U.S.G.S. Bull. 841
U.S.G.S. Bull. 863
U.S.G.S. Bull. 865
U.S.G.S. Bull. 908

The following Professional Papers are of interest:

Prof. Paper 131
Prof. Paper 132A
Prof. Paper 183

The following U.S.G.S. Oil & Gas Investigations Preliminary Maps & Charts are the most recent published on the area:

Prelim. Chart 2
Prelim. Chart 7
Prelim. Chart 16
Prelim. Chart 54
Prelim. Chart 55
Prelim. Chart 57
Prelim. Chart 93
Prelim. Chart 96

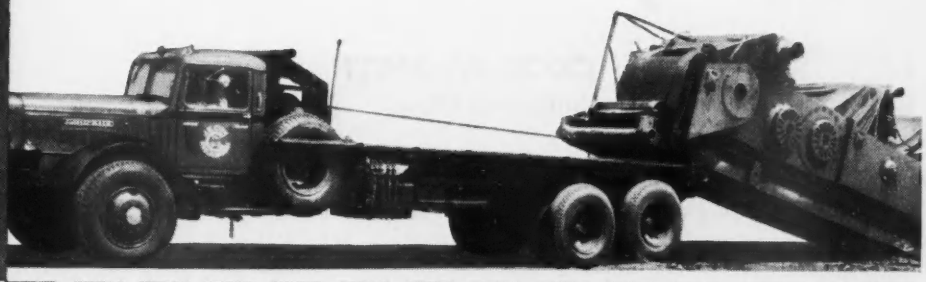
New Mexico School of Mines Bull. No. 18 "Oil & Gas Resources of New Mexico" describes most of the known structures in the San Juan Basin.

The map accompanying Bull. No. 16 Colorado Geological Survey shows the aerial geology of Southwestern Colorado which includes the Colorado portion of the Paradox salt basin and of the Colorado platform.

There is an incomplete map of the Paradox anticline and an article on the Colorado-Utah salt domes by Thomas S. Harrison in AAPG Vol. 11, No. 2 pp. 111-134. Other articles in AAPG are in Vol. 11, No. 8.

Guidebook to the Geology of Utah No. 3 by William Lee Stokes, Utah Geological Society, Salt Lake City, Utah, describes the stratigraphy of the salt basin and the theories as to the formation of the salt anticlines.

OIL-FIELD HAULERS



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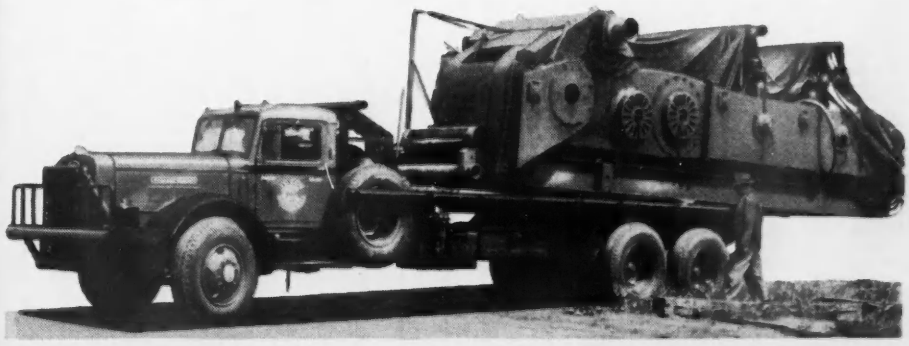

These action pictures show how J. E. Cox, oil-field hauler of Breckenridge, Texas, winches a drilling rig from the ground level up over rollers onto the body of his Autocar-Diesel six-wheeler — an operation that is unavoidable in the oil regions but is not endorsed by automotive engineers for general application.

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Exploration

Likely to Set Record

By CECIL W. SMITH
Statistical Editor

THERE were fewer exploratory wells completed in September than in any month since February, but the year's nine-month total held on to its almost 12 percent lead over last year's record-breaking exploration activity.

With only three months to go, it appears almost sure that 1949 will replace last year as the most active exploratory drilling year of all time. However, it is also quite possible that the present strike in the steel industry will cause some tubular shortages and further slackening of drilling rates.

The drilling industry has just gone through a period of lowering its inventories built up after the days of pipe shortages, and this new threat to steel supplies may catch many without enough tubular goods to carry out their entire drilling programs. If pipe scarcities do occur, wildcat drilling will be the first to show the effects, but even so 1949, with its present lead, should prove to be the top wildcatting year by a small margin.

Exploratory wells completed during September totaled 622, a slight drop

Summary of Results of Exploratory Drilling

ITEM	Sept., 1949	Aug., 1949	Nine Months January-September 1949	1948	Percent Dif.
Oil Discoveries	63	88	736	652	+ 12.9
New Fields	41	65	507	438	+ 15.8
New Pays	22	23	229	214	+ 7.0
Distillate Discoveries	8	8	101	74	+ 40.5
New Fields	7	8	58	43	+ 34.9
New Pays	1		46	31	+ 48.4
Gas Discoveries	20	12	113	109	+ 3.7
New Fields	19	8	94	79	+ 19.0
New Pays	1	4	19	30	— 36.7
Total Discoveries	91	108	953	835	+ 14.1
Extensions to Fields	27	21	200	152	+ 31.6
Oil Fields	23	20	179	121	+ 47.9
Distillate Fields	1	1	12	12	
Gas Fields	3		9	19	— 52.6
Total Prod. Tests	118	129	1153	987	+ 16.8
Dry Holes	504	518	4382	3974	+ 10.3
Wildcats	497	509	4321	3922	+ 10.2
New Pays			7	10	— 30.0
Outposts	7	9	54	42	+ 28.6
Total Expl'tory Tests	622	647	5535	4961	+ 11.6
Percent Productive	19.0	20.0	20.8	19.9	
Percent Dry	81.0	80.0	79.2	80.1	

Results of Exploratory Drilling in September and First 9 Months, 1949-1948, By Districts

State or District	MONTH OF SEPTEMBER, 1949														FIRST NINE MONTHS, 1949															
	Productive Tests									Total Productive	Unproductive Tests			Total Exploratory Tests	Productive Tests								Total Productive		Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions								New Fields			New Pays			Extensions									
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	9 Mo. 1949	9 Mo. 1948	Wildcats	New Pays	Outposts	9 Mo. 1949	9 Mo. 1948	9 Mo. 1949	9 Mo. 1948
Alabama																										10			10	14	10	14
Arizona																										4			4	1	4	1
Arkansas			1							1	7			8	5		2	5			1			13	6	56	1	2	59	76	72	82
California	1			1			1			3	44		1	48	9		2	9			12		2	34	42	272	3	3	278	159	312	201
Colorado											2			2	1									1	4	30		1	31	42	32	46
Florida											1			1												11			11	18	11	18
Georgia																										4			4	3	4	3
Illinois	3			1			6			10	60			70	17			25			40			82	71	433			433	379	515	450
Indiana							1			1	20			21	32			3			5			40	31	278			278	183	318	214
Kansas	4		1							5	40			45	58		5	4			6			73	57	296			296	343	369	400
Kentucky	1									1	9			10	10						2			12	7	39			39	43	51	50
Louisiana	4	3		4	1		3			15	18			33	25	15	4	26	14	1	8	1		94	91	175			175	172	269	263
North Louisiana	1			3	1		2			7	12			19	6	4	1	4	8		3			26	17	98			98	86	124	103
South Louisiana	3	3		1			1			8	6			14	19	11	3	22	6	1	5	1		68	74	77			77	86	145	160
Maryland																														1		1
Michigan	1		1			1				3	41			44	14		2			1	5			22	15	236		1	237	188	259	203
Mississippi											8			8	4			2						6	5	84		3	87	76	93	81
Missouri											1			1												6			6	14	6	14
Montana				1						1	2			3	3	1	1	1			1			7	4	23		1	24	23	31	27
Nebraska											1			1	1									1		5			5		6	
New Mexico	2									2	9			11	11		2	4						17	15	43		1	44	53	61	68
North Dakota											2			2												2			2		2	
Ohio											2			2							2		1	3	11	27			27	30	30	41
Oklahoma	5		2	6						13	30			43	44	3	7	21	1	3	17			96	86	331			331	352	427	438
Pennsylvania																	2							2		1			1	3	3	3
South Dakota											3			3												5			5	1	5	1
Tennessee															1									1	1	13			13	25	14	26
Texas	18	4	10	9			10	1	3	55	177		5	237	258	39	57	120	31	14	72	11	6	608	501	1827	3	36	1866	1700	2474	2201
Dist. 1 S. Central	2						1			3	18		1	22	15			1			2			18	6	176		3	179	136	197	142
Dist. 2 Middle Gulf	1		1	1				1	2	6	16			22	7	14	8	6	8	4	1	5	3	56	58	124		5	129	139	185	197
Dist. 3 Upper Gulf		2	2	3			1		1	9	11		2	22	15	13	7	39	11	2	5	3	1	96	88	177		2	179	202	275	290
Dist. 4 L. Gulf-SW	1	2		1			3			7	25		1	33	12	9	14	33	10	7	5	1		91	77	258	1	7	266	253	357	330
Dist. 5 E. Central											5			5	2	1						1		4	7	55			55	65	59	72
Dist. 6 Northeast											6			6	7	2	2	1	2			1	1	16	17	54	1		55	52	71	69
Dist. 7-B N. Central	3		3							6	50			56	87		15	15		1	5			123	101	428	1	3	432	308	555	409
Dist. 7-C W. Central	2			1						3	7			10	14		3	5			8			30	20	73		2	75	70	105	90
Dist. 8 West	1		2	2			3			8	7		1	16	26		2	7			31		1	67	69	131		5	136	137	203	206
Dist. 9 North	8		2	1			2			13	30			43	72		6	13			15			106	57	345		9	354	335	460	392
Dist. 10 Panhandle											2			2	1									1	1	6			6	3	7	4
Utah											5			5	2						1			3	4	16		1	17	12	20	16
Virginia																									1						1
Washington																													2		2
West Virginia			4							4	1			5			10							10	4	3			3	3	13	7
Wyoming	2						2			4	14		1	19	12			9			7			28	31	91		5	96	58	124	89
Total U.S.	41	7	19	22	1	1	23	1	3	118	497		7	622	507	58	94	229	46	19	179	12	9	1153	987	4321	7	54	4382	3974	5535	4961

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from the 647 drilled in August, but a greater decrease from the 664 wells averaged during the previous six months. Although the past month's completions topped those of September a year ago, a further comparison with last year shows that last September's wells held an advantage over its previous six-month average, which, as pointed out above, was not true this year. All of which shows that even though this year holds a lead over last year's wildcatting, the trend is downward now while a year ago activity was holding high.

Along with the small cutback in exploratory wells completed in September compared with those in August, came some loss of luck for the wildcatters. Out of the month's 622 tests, 118 or 19 percent were rated as commercial producers, while a month earlier 20 percent made good. New gas discoveries showed an increase, but new oil finds dropped.

In the first nine months of 1949 there were 5535 exploratory tests completed to give the year a 11.6 percent advantage over the 4961 completions made in the first three quarters of 1948. Not only has the current program been more extensive, but it has been more successful percentage-wise. So far, 1153 producers have accounted for 20.8 percent of the total drilled, while last year's 987 successful tests amounted to 19.9 percent.

The above rates of successful exploration show that for both years about one out of every five tests drilled produced. These figures include rank wildcats, semi-wildcats, outposts, and new pay tests. Taking the strict wildcats alone it is found that so far this year 13.2 percent of all wildcats drilled opened new fields and a year ago this rate had been 12.5 percent. Putting it another way, so far this year it has taken 7½ wildcat tests to open a new producing area, while a year ago it took eight tries to find a new field. The experience in the 11 years prior to 1948 was an average of 8½ attempts to one hit.

New oil fields credited to 1949 efforts totaled 507 in the first nine months against 438 in last year's comparable period. New oil horizons in existing fields numbered 229 compared to 214 a year ago. These totaled 736 new oil pools against 652 in 1948, a gain of 12.9 percent. This is slightly better than the 11.6 percent gain in total exploratory drilling.

Distillate discoveries made the greatest percentage gain with 58 new areas against 43 last year and 46 new pay horizons to 31. These totaled 104 new pools to 74 for last year, an increase of 40.5 percent.

Little change was shown in new dry gas pools, they being 113 this year against 109 a year ago, a gain of 3.7 percent.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in United States in September, 1949

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Gas Field						
Franklin	"Cecil"	Arkansas-Louisiana Gas Co's Ralph S. Barton 1, SE SE NW 27-9n-28w, 2 mi sw Cecil.	9-26-49	6650	4850- 4930	Hale sd; Penn	7 mln: open	....
		CALIFORNIA—New Oil Field						
Santa Barbara	Fourdeer, S.	Sunray Oil Corp's Los Flores 13, Sect. 9-8n-33w, 1 mi s Fourdeer fld.	9- 8-49	6012	5678- 5887	Chert	P 100	30.4
		CALIFORNIA—New Oil Pay						
Kern	Wasco	Standard Oil Co's Mushrush 5, (OWDD), 510 s 330 e fr center 7-27s-24e. World's deepest producer.	8-27-49	15866	15250-15530	Eocene	F 336; 4/16"	32.7
		CALIFORNIA—Oil Field Extension						
Santa Barbara	Cuyama, S.	Alphonzo R. Bell Corp's Johnston 45-6, 330 s&w fr center 6-9n-26w, ⅜ mi se extension.	8-28-49	4415	4102- 4370	Homan sd; Mio	F 360; 5/32"	32
		ILLINOIS—New Oil Fields						
Edgar	Elbridge	Nat'l Assoc. Pet. Co. & Continental Oil Co's H. S. Cockeroft 1, NW NW SW 1-12n-11w.	9-13-49	2093	969- 973	Ste. Genevieve li; Miss	P 50; 50 wtr	....
Franklin	Thompsonville, E.	Carter Oil Co's Trustee Tract 8-1, SW NW NE 12-7s-4e, 2 mi e Thompsonville, N. pl.	9-20-49	3158	3148- 3158	Aux Vases sd; Miss	P 489	....
Randolph	Sparta, S.	Kleiboeker & Schnitzmeyer's A. B. McMillan Hrs. 2, NW NE SE 7-5s-5w.	9-20-49	900	880- 888	Cypress sd; Miss	P 1; 1 wtr.	....
		ILLINOIS—New Oil Pay						
Marion	Raccoon Lake	The Texas Co's Scott-Aydt Unit 1, SE NE SW 3-1n-1e	9-20-49	2025	1653- 1666	Cypress sd; Miss	P 72; 23 wtr	....
		ILLINOIS—Oil Field Extensions						
Christian	Assumption, N.	Collins Bros.' Seifert 1, SE NE NW 3-13n-1e, ½ mi n extension	9- 7-49	2319	2311- 2315	Devonian li; Devo	P 22; 18 wtr	....
Edwards	Browns, S.	C. E. Skiles' J. Curtis 1, SW SE SE 31-1s-14w, ½ mi s extension	9-20-49	3140	3113- 3117	McClosky li; Miss	P 14; 7 wtr	....
Fayette	Louden	W. L. Belden's W. Grames 1, SW NE NW 25-8n-3e, ½ mi e extension	9-27-49	1528	1492- 1512	Cypress sd; Miss	P 130	....
Gallatin	Inman Cent.	Oil Management Co's Downen 1, SE SW NE 7-8s-10e, 1 mi s extension	9-13-49	2145	2128- 2144	Tar Springs sd; Miss	P 76; 12 wtr	....
Lawrence	Lancaster	P. Graebling's B. Cook 1, SE NW SE 28-2n-13w, ½ mi n extension	9-20-49	2533	2509- 2531	Bethel sd; Miss	P 3; 60 wtr	....
Richland	Dundas, E.	Bell Bros.' Porter-Seiler 1, NW NE SE 3-4n-10e, 1¼ mi sw extension	9-13-49	3018	2986- 2992	L. O'Hara li; Miss	P 81	....
		INDIANA—Oil Field Extension						
Knox	St. Thomas	J. E. Bauer's J. M. & E. H. Brevoort 4, NE NE NW 27-2n-11w, w extension	9-20-49	1921	1767- 1787	Benoist sd; Miss	P 35	....
		KANSAS—New Oil Fields						
Barton	McCauley	Bay Pet. Corp. & C. E. Ash's McCauley 1, NW NW SE 34-17s-13w, ½ mi s&e Klug pl.	9-13-49	3408	3276- 3280	Lansing-K.C. li; Penn	P 121; 34 wtr	36
Barton		Ben F. Brack's Koch 1, NW NW NW 19-17s-14w, 2 mi nw Carroll pl.	9-16-49	3411	3399- 3411	Arbuckle li; Ord	P 36	....
Butler		K. T. Wiedemann's Rombold 1, SE SE SE 4-26s-3e, ¾ mi w Parsley pl.	9- 6-49	2771	2762- 2771	Mississippi sd; Miss	P 30	....
Stafford	Oscar	Anschutz Drlg. Co's Smith 1, NW NW SW 24-22s-14w, 3 mi sw Curtis pl.	9-27-49	3805	3797- 3805	Arbuckle li; Ord	P 250	....
		KANSAS—New Gas Field						
Cowley		G. T. Lackey's Manser 1, NW NW SE 25-31s-6e, 4½ mi e Burden pl.	9- 9-49	2917	2470- 2489	Kansas City li; Penn	1.2 mln	....
		KENTUCKY—New Oil Field						
Union		Hartman-Calvert & Willis Inc.'s Meredith 1, S½ E½ 11 -P-18, e side of Wabash Island in Ohio River.	9-16-49	2797	2308- 2345	Cypress sd; Miss	P 30	....
		NORTH LOUISIANA—New Oil Field						
Winn		C. M. Bagley's Tremont Lbr. Co. 1, C NW NW SW 25-12n-2w, Joyce area.	9- 6-49	1121	1112- 1121	Wilcox sd; Eoc	P 33	22
		NORTH LOUISIANA—New Oil Pays						
Caddo	Caddo-Pine Island	Lakeside Oil Co's Hales-Files et al 1, 275 fr wl 2045 fr sl SE 29-20n-15w	9-20-49	2336	2270- 2321	Fredricksburg, li; L Cre	F 140	....
Caddo	Waskom	Stanolind O&G Co's J. D. Abney 1, C NE NE 31-17n-16w	9-13-49	4053	3887- 3900	Mooringsport li; L Cre	P 65; 6 wtr	43
Claiborne	Haynesville	B. F. Phillips' Sale 1, 518 fr n&el SW 20-23n-8w	9-12-49	10870	10732-10755	Smackover "B" li; Jur	F 281; 4/32"	44
		NORTH LOUISIANA—Oil Field Extensions						
Catahoula	Lake Larto	Marine Oil Co's Farrar 1, C NE SW 19-5n-6e, 2 mi se extension	9-25-49	6024	5855- 5857	Wilcox sd; Eoc	F 168; 11/64"	37.3
Claiborne	Lisbon	Sklar Oil Corp's Duke Unit 1, C SW SW 18-21n-4w, 1 mi nw extension	9-27-49	5070	5058- 5066	Pettit li; L Cre	F 1272; 3/8"	34.6
		NORTH LOUISIANA—New Distillate Pay						
Bienville	Bear Creek	C. H. Murphy & Co's Fitts 1, 385 n 165 e of center 9-16n-5w	9-25-49	8584	7913- 7935	Fitts sd; L Cre	F 2; 6.2 mln; 4/16"	56.5
		SOUTH LOUISIANA—New Oil Fields						
Acadia		P. A. Ward Co's Winnifred B. Vincent 1, 330 s&e of center 14-7s-1w, ½ mi s Ritchie fld.	9-10-49	4032	3681- 3686	Miocene	F 74; 4/12"	25

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian: U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in United States in September, 1949

(CONTINUED)

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
Iberia	Rabbit Island	The Texas Co's St. Lse 340-Rabbit Island 14, n flk Rabbit Island Dome, Atchafalaya Bay, 10 mi sw Horseshoe Bayou fld.	9- 1-49	10705	8824- 8850		F 292; 5/64"	36.5
Plaquemines		Humble O&R Co's State-Lake Washington, Lse 1465-1, sw of old Lake Washington prod.	9-20-49	9653	8617- 8623		P 240	30.3
		SOUTH LOUISIANA—New Oil Pay						
Acadia	Bayou Mallet, S.	Union Sulphur Co's Richard Unit 1-A, 1991.6 s 2431.9 w of NEC 25-7s-1e.	9-15-49	9651	9177- 9182		F 62; 5/64"	30
		SOUTH LOUISIANA—Oil Field Extension						
Acadia	Ritchie	P. A. Ward's John Wilfert 2, 330 s&w of center 14-7s-1w, 2 mi ne extension	9-29-49	3975	3414- 3416	Miocene	F 65; 5/64"	24.7
		SOUTH LOUISIANA—New Distillate Fields						
Cameron		Superior Oil Co's Gulf of Mexico-State B-Lse 1-A, West Cameron Blk 149	9-16-49	9380	7150- 7160		F 7; 3.4 mln; 5/32"	43.5
Iberia		Union Oil Co's State Lse 1700-1, 700 fr n shore line of Vermilion Bay, Twp 14s-5e, S. Tigre Lagoon area.	9-25-49	11761	11400-11415		F 39; 1.7 mln; 1/8"	47
Plaquemines		Gulf Refg. Co's State 2-QQ, 12830 n 8480 e of SWC of Twp 17s-17e, Black Bay area.	9-29-49	10212	10095-10102		F 87; 5.4 mln; 1/4"	54.2
		MICHIGAN—New Oil Field						
Bay		Don Rayburn's Cooper-Lucht 2, NE SW NE 29-17n-4e, Pinconning Twp.	9- 2-49	2238	2234- 2238	Traverse li; Devo	P 94	....
		MICHIGAN—New Gas Field						
Muskegon		P. K. Degenther's Lynch 1, NE SE SE 7-10n-15w, Eggleston Twp.	9- 9-49	2250	1040- 1100	Berea sd; Miss	0.5 mln	....
		MICHIGAN—New Gas Pay						
Mecosta	Paris	Cities Service Oil Co's Brennan 1, SE NE NW 28-16n-10w, Green Twp.	9- 9-49	3545	3404- 3439	Dundee li; Devo	1.8 mln	....
		MONTANA—New Oil Pay						
Blaine	Bowes	Northern Ordnance, Inc's Goertzen 1, SW NW NE 2-31n-19e.	9-15-49	3586	3377- 3415	Ellis li; Jur	P 200	....
		NEW MEXICO—New Oil Fields						
Lea		Amerada Pet. Corp's State 1-BTB, 660 fr n&wl 26-12s-33e, 4 mi s BTA area	8-26-49	11199	10155-10166	Devonian li; Devo	F 937; 1/4"	59.3
Lea		Stanolind O&G Co's Leonard-Federal 1, 660 fr s&el 11-26s-37e	9-12-49	12065	9396- 9425	Devonian li; Devo	F 24; open	38
		OKLAHOMA—New Oil Fields						
Cimarron	Keyes, SE.	Bay Petroleum Corp's Frank Parkes 1, NE NE SW 34-4n-8ecm	9-10-49	4845	4764- 4818	Keyes sd; Penn	F 49; 5/8"	....
Hughes	N. Atwood	Coronado Oil Co's Stephenson 1, (OWWO), NE NE NW 15-6n-9e, 1½ mi s & 3 mi w Horn's Corner fld.	9-15-49	5449	2800- 2819	Booch sd; Penn	P 32	35
Hughes		W. A. Delaney, Jr's Mattie Logsdon 1, NW SE NW 2-8n-9e, midway btw Long & Fuhrman pls.	9- 8-49	3330	3317- 3330	Cromwell sd; Penn	P 32	....
Okfuskee	Valley Grove, NW	M. B. Armer, W. O. Allen, Jr. & Culhsm Pet. Co's Seran 1, SW NE SW 30-13n-9e.	9-16-49	4120	3419- 3449	Dutcher sd; Penn	P 30	....
Payne		Thos. N. Berry's Bryant 1, NE SE NE 10-18n-4e.	9-14-49	3144	3135- 3144	Peru sd; Penn	P 24; 24 wtr	....
		OKLAHOMA—New Oil Pays						
Garvin	Lindsey, E.	R. L. Bauman & Max Pray's Hinkle 1, (OWDD), C NW SW 6-4n-3w.	9-12-49	11163	11034-11064	Oil Creek sd; Ord	F 200; 3/32"	35
Hughes	Pecan Grove	Gulf Oil Corp's Davis-Murta 1, (OWDD), SW SW NW 20-8n-9e.	9-15-49	4353	4300- 4395	Wilcox sd; Ord	P 7	....
Kay	Newkirk	C. R. Colpitt's L. B. James 1, SE SE SW 14-28n-3e.	9- 6-49	2998	2984- 2994	Prue sd; Penn	F 175; ½"	....
McClain	Bradley, E.	Cities Service Oil Co's Dacus 1, (OWWO), C NW SW 29-5n-4w.	9-19-49	11760	11245-10354	Chimney Hill li; Sil	F 425	....
Pottawatomie	Avoca	Flynn Oil Co's Cecil 2-B, NW SE NE 6-6n-4e.	9- 6-49	4090	4071- 4090	Hunton li; Devo	P 9	35
Stephens	Cruce	Skelly Oil & Mercury Drlg. Co's Brittain 1, SE SW NE 5-1s-5w.	9-23-49	7042	4234- 4280	Pennsylvania sd; Penn	P 20	38
		OKLAHOMA—New Gas Fields						
Caddo		W. B. Cleary & N. Bert Smith's Young 1, SW NW NW 36-5n-12w, 4 mi s Apache pl.	9-28-49	754	241- 254	Pontotoc li; Penn	0.05 mln	....
Pittsburg		Intex Oil Co's Welsh Unit 1, C NW SW 35-6n-15e, 4 mi e McAlester.	9-20-49	2010	1164- 1185	Atoka sd; Penn	1.4 mln	....
		TEXAS—District 1 (S. CENTRAL)—New Oil Fields						
McMullen	Green Franklin	Rowan & Hope, & Massingill's H. M. Roark 1, 467 fr w&nl of S 80-ac of 192.26-ac Tr., J. M. Hernandes Sur 34, 8 mi n Tilden.	9-12-49	5792	5090- 5110	Wilcox sd; Eoc	F 61; 1/8"	28
Williamson	S. Coupland	Anderson-Pritchard Oil Corp's Theo. Schwenke 2, 120 ne'ly fr SWC J. Jordan Sur.	8-31-49	1330	1006- 1034	Dale li; U Cre	P 80	36
		TEXAS—District 1 (S. CENTRAL)—Oil Field Extension						
Frio	Charlotte W.	Lewis Oil Co's Oppenheimer & Lang 1-D, 2310 fr sl 1320 fr el D. F. Landrum Sur 2, ¾ mi sw extension.	9-12-49	5580	5557- 5580	Navarro sd; U Cre	F 30; 1/8"	29.1
		TEXAS—District 2 (MIDDLE GULF)—New Oil Field						
Bee	Goree	Skelly Oil Co's G. W. Goree 1, 330 fr n&el Lot 38, Yoward Ranch Sbdn, Thomas Barton Sur, 1 mi n Yoward fld.	9- 8-49	8202	7199- 7202	Luling sd; Eoc	F 61; 11 wtr; 7/64"	40.4
		TEXAS—District 2 (MIDDLE GULF—New Oil Pay						
Victoria	Placedo	Barnsdall Oil Co's Emil Kruppa 1, 950 fr nel 2300 fr nwl Wm. Rupley Sur.	9-30-49	6066	5696- 5700		F 165; 5/64"	28
		TEXAS—District 2 (MIDDLE GULF)—Distillate Field Extension						
Lavaca	Provident City	Shell Oil Co's Fay Rouse 1, 3000 fr nel 2500 fr nwl Aaron Monroe Sur, 1¼ mi se extension.	9-19-49	9171	8890- 9020	Wilcox sd; Eoc	F 92; 4.6 mln; 11/64"	43.5
		TEXAS—District 2 (MIDDLE GULF)—New Gas Field						
Calhoun		Brazos O&G Co's Powderhorn Co. 2, 300 fr nwl 400 fr nel Sect. 4, Blk J. Juan Cano Sur, 5 mi nw Port O'Connor.	9- 8-49	5150	4650- 4660		23 mln; open	....
		TEXAS—District 2 (MIDDLE GULF)—Gas Field Extensions						
Refugio	Fagan	James Doughty's T. C. Holeman 1, 1550 fr sel 2300 fr swl M. Reilly Sur, ¾ mi e-se extension.	9-20-49	2370	2090- 2095 2353- 2363	Oakville sd; Mio	15 mln; open 19 mln; open	....
Victoria	Welder Ranch	Sterling O&R Co's J. J. Welder 2-B, 1658 fr nel 1162 fr nwl S. A. Belding Sur, 1 mi se extension.	8-26-49	6006	5654- 5668	Frio sd; Olig	1.3 mln; 7/16"	....
		TEXAS—District 3 (UPPER GULF)—New Oil Pays						
Galveston	Gillock, S.	Pan American Prod. Co's Scofield Comm. 1, 290 fr sl 500 fr el Blk 4, Sbdn "N," Kohfeldt Re-sbdn of James Smith Sur.	9-24-49	9660	9555- 9560		F 239; 5/32"	37.8
Liberty	S. Liberty	Cities Service Oil Co's O'Brien 4-E, 390 w 250 s of SEC 98.66-ac Lse, M. G. White Sur.	9 -7-49	7148	5776- 5810	Yegua sd; Eoc	F 247; 3/16"	41.2
Polk	Copeland Creek	A. O. Phillips' Roger W. Armitage 1, 330 fr ne&sel of 50.09-ac Lse, Augustine Viesca Sur.	9-28-49	3352	3338- 3344	Jackson series sd; Eoc	F 117; 1/8"	27
		TEXAS—District 3 (UPPER GULF)—Oil Field Extension						
Brazoria	Damon Mound	John F. Merrick et al's Bryan Est. 1, 1050 fr sl 870 fr wl A. Darst Sur, sw extension.	8-28-49	3801	2390- 3348		F 85; 5/32"	....
		TEXAS—District 3 (UPPER GULF)—New Distillate Fields						
Galveston		Stanolind O&G Co.-Ohio Oil Co. & Melben Oil Co's State Lse 31700-1, 660 fr n&el of NE¼ Tr. 245, 18 mi in Gulf of Mexico.	9- 6-49	11017	5964- 5968		F 49; 5.1 mln; 1/4"	54.6
Grimes		E. G. Goforth et al's E. G. Goforth Fee 1, 466 fr el 1400 fr sl Wm. Berryman Sur, 1 mi sw Todd.	8-22-49	8500	7604- 7611	Wilcox sd; Eoc	F 94; 5.4 mln; 1/8"	64.2
		TEXAS—District 3 (UPPER GULF)—New Gas Fields						
Matagorda		Grubb & Hawkins' Margerum et al Unit 1, 1320 fr wl 458 fr sl 80-ac Tr., Lewis Goodwin Sur, s of Palacios fld.	8-27-49	9308	9150- 9218		No gge	....
Montgomery		Sterling O&R Co.-Daugherty & Kidd's W. Schiel 1, 91.35-ac Lse., T. J. Stansbury Sur, 2 mi nw Tomball fld.	9-15-49	5675	5486- 5491	Cockfield sd; Eoc	10.4 mln; open	....
		TEXAS—District 3 (UPPER GULF)—Gas Field Extension						
San Jacinto	Evergreen	Butcher-Arthur, Inc. et al's Lelah Polk 1, 2700 fr nly nel 9900 fr nly sel Vital Flores Sur, ½ mi ne extension.	9- 7-49	7714	7571- 7581	Wilcox sd; Eoc	No gge	....
		TEXAS—District 4 (LOWER GULF-SW)—New Oil Field						
Duval		Gasoline Prod. Corp., Ralph & Dale H. Rowden's John P. Akin-State of Texas 1, 330 fr s&el F. E. Stearns Sur 184, 11½ mi sw Freer.	9-29-49	2806	2155- 2163		P 61	25

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

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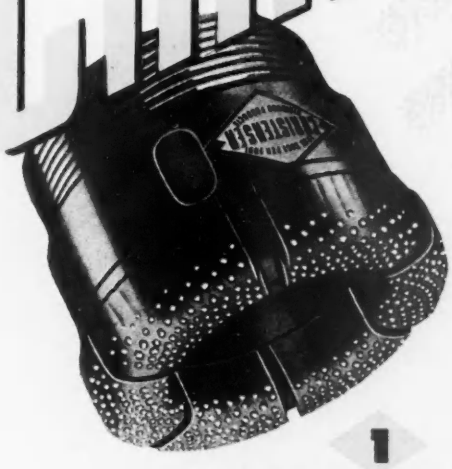

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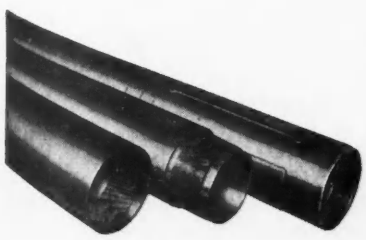

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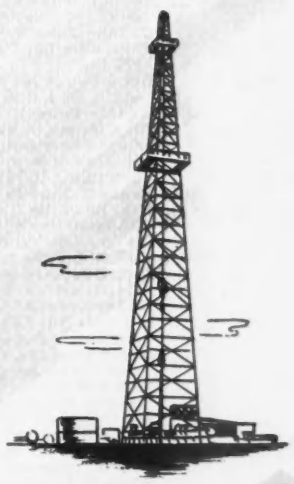

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in United States in September, 1949

(CONTINUED)

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 4 (LOWER GULF-SW)—New Oil Pay						
San Patricio	Morgan	Reed & Morgan's A. H. Wilson et al 1, (OWWO), 330 fr s&el Lot 9, Coleman-Fulton Pstr Lds Sbdn., Geo. Morris Sur.	8-29-49	6943	5922- 5925		F 75; ½"	37
		TEXAS—District 4 (LOWER GULF-SW)—Oil Field Extensions						
San Patricio	White Point, E.	H. R. Smith et al's John G. Davis 1, 660 fr nl 330 fr el Sect. 62, Geo. H. Paul Sbdn., Coleman-Fulton Pstr Lds, ½ mi e extension.	9-11-49	3663	5656- 5659	Frio sd; Olig	F 142; ⅛"	39.6
Starr	Borosa	Continental Oil Co's Mrs. O. H. Davenport 7-D, 330 fr el 990 fr nl Sur 282, 8/10 mi n-ne extension.	9-12-49	5904	4180- 4190	Frio sd; Olig	F 231; ⅜"	48.7
Starr	Rincon, N.	Taylor Ref. Co's Claud King Sr. 1, 467 fr el 1400 fr sl Sur. 511, sw extension	9-20-49	5512	4210- 4217	Frio sd; Olig	F 30; 7/16"	42.9
		TEXAS—District 4 (LOWER GULF-SW)—New Distillate Fields						
Kleberg	Laguna Larga	Humble O&R Co's King Ranch-East Laureles 1-G, Rincon de los Laureles Fm Tr. 123, 16 mi s Corpus Christi.	9-15-49	12005	6497- 6505	Frio sd; Olig	F 280; 35 mln; open	478.4
Zapata	Cinco de Mayo	W. B. Jayred's Jose M. Gutierrez 1, 660 fr se&swl 3657 fr nwl of 1176.5-ac Lse in Blks 2 & 4, Sh 1, Porc. 30, 1¼ mi se Echols fld.	9- 1-49	6515	2300- 2310	Queen City sd; Eoc	F no gge; 3.5 mln	60
		TEXAS—District 7-B (N. CENTRAL)—New Oil Fields						
Coleman		Dunham, Young & Shields' Calvin Campbell et al 1, 5650 fr wl 1600 fr nl Mary Ann Fisk Sur 630, 3½ mi e Santa Anna.	9-11-49	2355	2311- 2355	Marble Falls li; Penn	F 410; 5/32"	29.8
Comanche		The Beltana Corp's G. W. Pinson 1, 990 fr se&swl Sect. 53, Blk 2, H&TC Sur, 1¼ mi se Kirk fld.	8-24-49	2820	2762- 2798	Marble Falls li; Penn	F 8; 11/64"	42
Parker		Buss Morgan et al's Darrell O'Neal 1, 330 fr n&el M. Waugh Sur, 2 mi nw Springtown.	9-23-49	6688	6662- 6685	Ellenburger li; Ord	F 33; 34 wtr; 7/16"	45.5
		TEXAS—District 7-B (N. CENTRAL)—New Gas Fields						
Erath		Continental Oil Co's C. H. Polk 1, 330 fr nwl 1200 fr nel G. West Sur, 3¼ mi sw Huckaby.	9-14-49	4200	4167- 4200	Ellenburger li; Ord	0.7 mln	....
Parker		Roger B. Owing's T. B. Saunders 1, 1975 fr nl 1550 fr wl Hudson-Westbrook Sur, 5 mi sw Weatherford.	9- 9-49	6509	4543- 4559	Mississippi li; Miss	4.4 mln	....
Stephens		The Texas Co's O. T. Tomlin 1, 330 fr nl 1335 fr el SE Sect. 87, BAL Sur, 8 mi sw Breckenridge.	9-12-49	3950	3610- 3622	Lake sd; Penn	4.1 mln	....
		TEXAS—District 7-C (W. CENTRAL)—New Oil Fields						
Runnels		Woods Drlg. Co's Carl Vogler 1, 3800 fr nl 6100 fr wl J. C. McKean Sur 534, 2½ mi w Freeman fld.	9- 9-49	2366	2349- 2366	Gunsight li; Penn	P 125	42
Schleicher		Ohio Oil Co's A. L. Baugh et al 1, 660 fr s&el Sect. 18, Blk M, GH&SA Sur, 5½ mi nw Page-Strawn fld.	5-28-49	6775	5790- 5800	Strawn sd; Penn	P 50; 257 wtr	39.8
		TEXAS—District 7-C (W. CENTRAL)—New Oil Pay						
Runnels	Runnels	The Texas Union Oil Corp's Bradley 1, 660 n 343 e of SEC Sect. 163, but in W. Holmes Sur 100, 5 mi n Ballinger.	9-14-49	4038	4008- 4023		F 5	45
		TEXAS—District 8 (WEST)—New Oil Field						
Scurry	"Winfield"	Stanolind O&G Co's R. H. Jordan 1, 680 fr el 2652 fr nl Sect. 579, Blk 97, H&TC Sur, 3 mi nw Fluvanna.	8-11-49	8922	8220- 8260	Mississippi li; Miss	P 47; 30 wtr	39.8
		TEXAS—District 8 (WEST)—New Oil Pays						
Gaines	Flanagan	Magnolia Pet. Co's Flanagan Est. 1, 1980 fr nl 660 fr wl Sect. 9, Blk A-23, PSL Sur.	9-13-49	12255	10345-10382	Devonian li; Devo	F 537; ½"	34
Sterling	Water Valley	York & Harper, Inc. & J. C. Gibbins' L. C. Clark 2, 2416 fr el 2340 fr sl Sect. 6, Blk 4, R. R. Wade Sur.	9- 1-49	874	840- 870	Clear Fork li; Perm	P 16	24.3
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Cochran	Levelland	Cain & Maxey's St. Clair 1, 440 fr sl 824 fr el Lab 14, Lge 130, Carson CSL Sur, 2 mi n extension.	6-25-49	4880	4840- 4880	San Andres li; Perm	P 49; 3 wtr	31
Lubbock	Cravens	Slick Oil Co. & Moorman Oil Co. et al's Floyd Cloud 1, 660 fr el 1980 fr sl Sect. 22, Blk D, L&SV Sur, ¾ mi sw extension.	9- 9-49	6144	6134- 6144	Clear Fork li; Perm	P 36; 84 wtr	28
Scurry	Sharon Ridge Canyon	Thomas W. Doswell's C. W. Addison et al 1, 660 fr n&el N½ SE¼ Sect. 122, Blk 25, H&TC Sur, 1 mi w extension.	9-12-49	6677	6636- 6672	Canyon li; Penn	F 504; 7/16"	42.7
		TEXAS—District 8 (WEST)—New Gas Fields						
Crockett		The Texas Co's Victor L. Pierce 1, 988 fr nl 2034 fr el Sect. 5, Blk 0, C. W. Brown Sur, 21½ mi se Ozona.	7-19-49	11969	11775-11812		4.4 mln; ¾"	....
Terrell		Western Natural Gas Co's O. J. Hoge 1, 660 fr nl 1980 fr el Sect. 29, Blk 161, GC&SF Sur, 35 mi s Sheffield.	9-27-49	5910	5250- 5417	Permian sd; Perm	0.6 mln	....
		TEXAS—District 9 (NORTH)—New Oil Fields						
Archer		E. B. Clark Drlg. Co's Claude A. Miller 1, 1266 fr nl 330 fr el Blk 21, Mangold Sbdn, 1½ mi se KMA fld.	8-29-49	4044	3558- 3570		P 59	42
Archer		Neeld & Hood Drlg. Co's J. S. Bridwell 1, 150 fr n&wl Blk 17, W. B. Aldridge-Jackson Sbdn, 9 mi n Archer City.	9-20-49	1592	1588- 1592		P 25	41
Archer		Neeld & Hood Drlg. Co's L. F. Wilson Est. 1, 330 fr n&el Lot 3, Blk 59, ATNCL Sur, 2 mi n Chalk Hill, N. fld.	9-30-49	3976	3962- 3976	Strawn sd; Penn	F 840; ½"	42
Clay		Jack Grace Prod. Co's D. M. Cobb 1, 1775 fr nl 2490 fr el J. Scott Sur, 2 mi ne Watson fld.	8-30-49	5600	5595- 5600	Caddo li; Penn	F 408; ¼"	41
Jack		Revier Drlg. Co's Helen Slusher 1, 1301 w 581 n of NWC J. V. Stewart Sur in J. Harrison Sur, 2½ mi se Worsham-Steed fld.	9- 5-49	5104	3679- 3692		P 32	....
Jack		Warren Oil Corp's Gresham-Davis 1, 355 fr sl 472 fr wl John Little Sur, 1½ mi s Lester fld.	9-24-49	6051	5730- 5780	Ellenburger li; Ord	F 193; 7/32"	44
Wichita		Hale & West's W. V. F. McKinnon et al 1, 2600 fr el 4100 fr nl Unit 86, W. M. Lloyd Sur, 2 mi ne Norwood fld.	9-24-49	4380	4367- 4377		P 68	43
Young		Walter Grammar's Mrs. Addie Carter 1, 450 fr sl 750 fr wl SE¼ Sect. 1594, TE&L Sur, 8 mi w Olney.	7-20-49	1187	1186- 1187		P 7	38
		TEXAS—District 9 (NORTH)—New Oil Pay						
Cooke	Unnamed	Snuggs & Neal, Inc's G. A. Lemaster et al 2-A, 330 fr s&wl NE SW Blk 2, Lge 7, University Lds.	9-17-49	3384	3379- 3384		P 48	34
		TEXAS—District 9 (NORTH)—Oil Field Extensions						
Cooke	Woodbine	Britton-Fitzhugh & Powell's B. V. McCorkle 1, 330 fr s&wl of N/280-ac of Roma Dye Sur, 1½ mi se extension.	9-17-49	4522	4514- 4522	Strawn sd; Penn	P 147	42
Wilbarger	Unnamed	W. T. Waggoner Estate's Fee 2-TT, 2350 fr nl 2450 fr wl Sect. 21, Blk 3, H&TC Sur, 1 mi se extension.	9-11-49	4816	4795- 4816	Ellenburger li; Ord	F 480; ¼"	39
		TEXAS—District 9 (NORTH)—New Gas Fields						
Cooke		R. B. Hollandsworth et al's M. W. Thomason 1, 700 fr nl 2800 fr wl T. D. Bell Sur, 1½ mi s Leo.	9-23-49	2392	2300- 2346		1 mln	....
Young		Willis Drilling Co's G. R. Funk 1, 330 fr s&wl W. R. Oxford Sur, 4 mi se Bunger.	9-10-49	2314	2300- 2314		25.4 mln	....
		WEST VIRGINIA—New Gas Fields						
Preston		Nollem O&G Co.- Snee & Eberly's Hugh R.-James A. Fitzpatrick 1, Portland district.	9-19-49	6221	5652- 5660	Oriskany sd; Devo	0.2 mln	....
Wood		Godfrey L. Cabot, Inc's Benjamin Quick 1-1300, Steele district	9- 1-49	5103	5053- 5060	Oriskany sd; Devo	0.6 mln	....
Wood		Limestone Gas Co's L. W. Pfalzgraf 1, Steele district	9- 6-49	5085	5047- 5057	Oriskany sd; Devo	0.7 mln	....
Wood		United Carbon Co. et al's P. E. Province 1-1633, Steele district	9- 2-49	5226	5097- 5126	Oriskany sd; Devo	0.4 mln	....
		WYOMING—New Oil Fields						
Niobrara		Atlantic Refg. Co's State 36-1, NE NW NW 36-35n-66w, Lightning Creek area, 5 mi s Lance Creek fld.	9- 1-49	3991	3870- 3890	L. Sundance sd; Jur	P 297	41.7
Washakie		General Petroleum Co's Gov't. 37X-24 NW SE SW 24-47n-92w, South Frisby area.	7-25-49	10666	10641-10655	Embar li; Perm	P 81	33
		WYOMING—Oil Field Extensions						
Weston	Fiddler Creek, W.	Far West Oil Co's M. B. Walters 1, NE SE NW 29-46n-65w, 2½ mi sw extension.	9-10-49	5245	5212- 5227	Newcastle sd; U. Cre	F 385; ½"	....
Weston	Mush Creek, W.	Clark Drilling Co's Jansen 1, NE NW NE 3-43n-64w, extension	8-29-49	5300	5264- 5300	Newcastle sd; U. Cre	F 18	....

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

Well Completion Practices

Part 1
COMPLETIONS

By DR. CARROL M. BEESON
Associate Professor of Petroleum Engineering, University of Southern California

At this Venezuelan well, the cementing setup is much the same as found in other areas, with the possible exception of the bulk-handling of cement which is possible where transportation facilities are more advanced. This operation is one which is of extreme importance in successful completions.

THE AUTHOR examines the various factors which enter into well completions, evaluating the effect of each, and outlining practices which can be bettered as well as those which have proven adequate to certain types of well. This is the first of a four-part series on drilling practice fundamentals, in which the author will successively cover completions, completion fluids, well washing, and remedial work.

THE underlying purpose of this series of articles is to emphasize the need of progress in the completion stage of the drilling and production of oil wells. The fact that good production has been obtained from many wells which have been completed with little care is beside the point. Emphasis must be placed on the value of improvement and its need.

All phases of production depend to some extent upon the quality of the completion stage. Rewards from improvements in the arts of well drilling and oil production often may be throttled by lack of advances in completion technique. It is not meant to imply that completion practices are out of date; but rather, that further work is needed and that returns from such work will be even more remunerative than those made thus far.

As the art of drilling wells has advanced, emphasis has shifted toward changes in technique in order to obtain greater sustained production, rather than merely to drill into the producing horizon as cheaply as possible. This shift in thinking is a logical development. Experience and engineering analyses have indicated the value of quality in completions. In addition, fewer wells are being drilled to "gusher" pays. Furthermore, the belief gradually has arisen that some zones with lower formation pressures, with a greater clay content, or drilled with muds which enter the formation, have been partially or completely blocked.

The term "completion" as herein used includes every operation which occurs between the initial penetration of the top of the producing horizon and commencement of settled production. If the operations involved in drilling through the pay zone are excluded, any study of completion practice would overlook the damage, minor or serious as the case may be, which occurs during this period.

The damage that occurs during drill-in, and before initial production, will be elaborated upon, both as to probable cause and suggested cure. Advances in the art, and current developments in investigations now in progress, have al-

ready resulted in improvements which will continue to reduce such damage or facilitate corrective measures and yield more oil.

Effective Planning

Effective completion planning depends on the petroleum engineer's knowledge of the producing horizon. Before arriving at any decision as to which materials, tools, or techniques to use in preparing the well for production, many factors which contribute to the engineer's knowledge should be considered. These include the following:

1. A comprehensive coring program.
   Cores fully examined and tested for:
   a. Minerals present, including hydratable materials.
   b. Range of sizes of pores or channels.
   c. Grain-size analysis of friable formations.
   d. Permeability to gas and liquids.
   e. Character and quantity of contained fluids.
   f. Capillary characteristics and electrical resistivity.
   g. Possible damage from completion fluids, such as obstruction by filter cake, or blocking caused by penetration of mud particles or filtrate.

Core data are required to prepare the completion plan, as will be elaborated upon herein. The data are necessary for correlating logging, for reservoir engineering on producing zones, and for obtaining efficiency in any exploitation program.

2. Electrical logging. (Self potential, shallow penetration and selected deep penetration resistivity curves).

Logging data, correlated with core data, are used to determine the location of oil, water, and gas. In fields which have uniform formations, logging may eliminate some coring.

3. Caliper logging.

Besides useful extra and correlative data, these logs may show potential hazards to successful completion, such as thick filter cake, tight hole, caving, thin shells and interbedding. They are useful in cementing.

4. Side wall coring.

Coring omissions can be remedied; filter-cake formation and filtrate penetration can be checked.

5. Radioactivity logging.

Information otherwise unobtainable may be found, as well as further correlative data.

6. Temperature surveys.

Temperature gradients and bottomhole temperature data are useful in selection of completion fluids and in cementing, and are necessary for pressure-volume-temperature studies.

7. Formation testing.

This information determines the actual producable fluids, which usually may be sampled in quantity. Pressure data on formation fluids are ordinarily provided and are useful in selecting wash or flush fluids and drill-in fluids on succeeding wells.

8. Pressure surveys.

Pressure data should be obtained, if not already available from the formation test.

9. Water entry logging.

These data may be most useful, in certain cases, to enable successful well completion or for planning remedial work.

The best completion plan will be based on data on the actual pay zone in question. Data on offset wells must be relied on in the preliminary planning of the program, but the best results for a specific well will be realized by postponing final decisions until as much information as possible has been obtained during the drilling-in of the well itself.

Consider Each Case

Likewise, the best completion program for the orderly development of a lease or field requires selection of the best elements for each well. Each individual case must be considered in relation to the known data or, based on accumulated experience from previous wells, the most logical choice must be made where specific information is lacking. In lease or field development, programs should be guided by all engineering data available and helped by careful planning to continually obtain more information to permit better choice and more improvement with each successive well completed. All accumulated data relating completion practices to production, analyzed on a truly comparative and statistical basis, will reveal trends to follow for further improvement.

Experience shows that better wells follow the orderly development of large fields. In those cases, thorough analysis of producing histories and experience, tempered by careful planning, govern programs seeking continual improvement. Early wells, completed with inadequate knowledge or technique, have been worked over with well planned remedial programs, and the fields have been systematically produced with reasonable efficiency.

The individual completion program elements will be considered next.

All data available from the sources previously listed and discussed should be analyzed and the following determined:

1. Location, character, properties and thickness of zones to be produced.
2. Location of water or gas zones to be excluded.
3. Character of fluids to be produced.
4. Amount of mud loss to formations.
5. Presence of hydratable material in zones to be drilled during completion.
6. Permeability of plaster-cake.

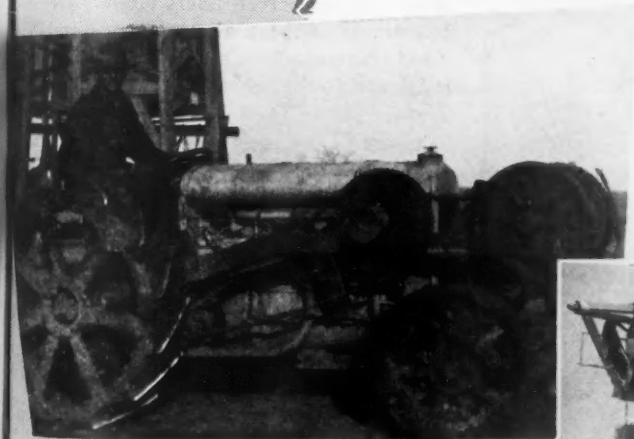
The choice of a completion fluid is related to some considerations under the first three headings, but more particularly to the latter three, which will be treated in succeeding articles. Determinations made under the first three headings influence the choice of materials,

Squeeze cementing is required when water must be shut off, or when the original cementing job fails to provide complete closure. It is also an important factor in equipping a well for dual production. Special automotive units enable squeeze cementing to be put through in a minimum of working time.

REMEMBER THE RED RIVER VALLEY?

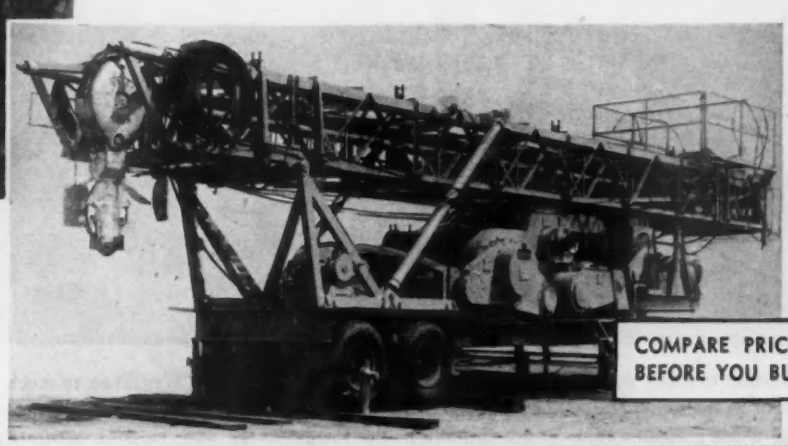
Only spot in the world where a roughneck could stand up to his knees in mud while the wind blew dust in his face! Texas and Oklahoma fought over this oil field. Texas Rangers, Federal Deputy Marshals, Oklahoma National Guardsmen were called out before it was settled. Uncle Sam won. Don't ask us why.

BUT Wilson *WAS THERE! AND WILSON WAS FIRST!*



Above: The daring young man on the tractor is John H. Wilson. The mud is familiar to all old timers.

The FIRST WILSON WINCH, the first practical commercial power winch, was built at Burkburnett in 1923. Designed by John H. Wilson, built on a Fordson Tractor furnished by the Caro Motor Company of Burkburnett, it was sold to W. M. Priddy of Wichita Falls, Texas. It ran for many years, and was the forerunner of thousands of Wilson Winches. This winch revolutionized oil well servicing. WILSON has had many FIRSTS since then!



Right: The MOGUL TORCAIR WINCH represents the most modern type of oil field servicing equipment. Wilson is still FIRST!

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tools and techniques, and will be discussed in this article.

Once the decisions are made as to what the well requirements are in the way of water shutoffs and gas exclusions, the next major step is to decide what specific means are to be used which will enable the well to produce at its maximum economical rate with minimum maintenance.

A completion program requires selection of specific materials, tools, and techniques based on the well needs. A classification of them follows:

1. Completion fluids.
2. Cementing techniques.
3. Liners and screens.
4. Completion time.
5. Drill-in techniques.
6. Pressure exerted on producing formation.

COMPLETION FLUIDS: Experience must govern the selection of mud for a wildcat well, otherwise data from preceding wells may be used. These fluids and their selection will be discussed later.

CEMENTING TECHNIQUES: Cementing is used in completing wells to exclude fluids which are not to be produced and to bond pipe to the formation. Developments which make it possible to obtain a better bond and seal, reduce the chance of contaminating producing formations, and speed up the process include:

Materials

Portland and gypsum cements and plastics with variable setting times suited to a range of formation conditions

Additives for setting-time adjustment, increased strength, reduced filtration, less slump, less penetration, better bonding.

Tools

Special cementing shoes

Improved squeeze tools

Scratchers

Guides

Techniques

Hole calipering

Faster cementing

Less delay before drill-out

Better checking techniques to determine extent and success of job

Pre-cementing wash fluids, flush fluids

Muds less harmed by cement

LINERS AND SCREENS: There are many important reasons for adequate screening to remove sand or other detritus. Among these factors are reduced wear on all mechanical equipment, such as pumps, rods, tubing, liners, valves, heads, lead lines, and traps. Details of selection of screen dimensions (slot, hole, gravel sizes) which are based on grain-size analysis and oil viscosity are not a part of this discussion. The selection of a liner or screen which will not plug easily in performing its screening is important, and corrosion must be considered.

The choice of the kind of liner or screen which will give the best results involves careful considerations of several factors:

Formation character.

Particulate matter which might be produced.

Zone thickness to be included.

Intervening zones.

Character of produced fluids.

The character of the formation is usually the prime criterion in determining the type and design of the liner. It is a comparatively simple problem, when the formation is well consolidated. A choice between slots, holes, or gun perforating could be based on the operators experience and wishes, tempered by the economics involved.

Consolidated formations which tend to break down easily and unconsolidated pays make the choice of the proper liner more difficult. The selection of a screen which requires minimum maintenance and which accomplishes satisfactory separation without reducing production is a worthwhile and richly rewarding objective of prime importance in these completions.

The types of liners and screens available include the following:

- Perforated liners using slots or holes.

Screen liners, wire wrapped, mesh covered holes or slotted-plate covered holes.

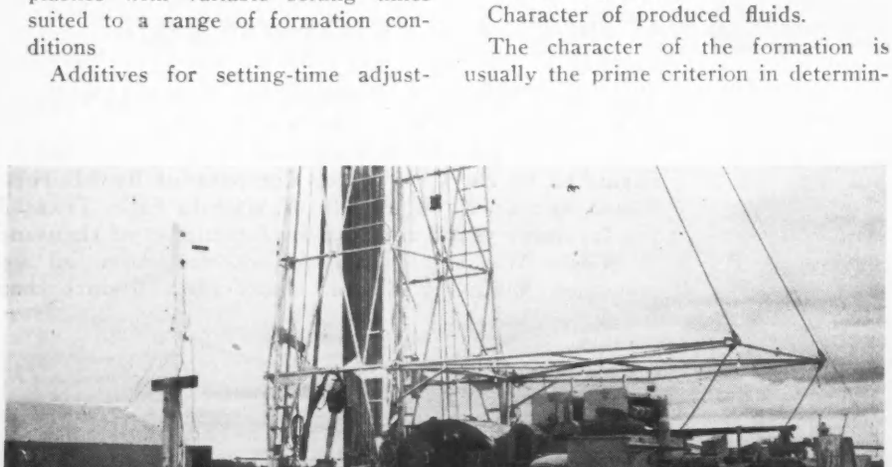
Prepack gravel liners.

Flow-pack gravel liners.

Perforated liners, called "conventional liners" by many, are in common use. Size, number, shape and type of perforations are subject to considerable variation, depending on criteria of the formation as determined by coring, and tempered by experience from checks on bailings and from production data. On the fine-sand end of the scale, slot widths of 0.015 inch have been used to control sands with ten percentiles as low as 0.008 inch. Generally, fine sands and silts have been controlled with varying success with different screen liners, prepacked gravel liners, or flow-pack gravel liners. Screen liners employ various means as listed above to yield small sized openings, high percentage of openings, and low construction and material costs.

In the prepack-gravel liner the well known property of gravel beds for trapping fine materials is used to remove the detritus. Prepacks are double liners with a thin gravel sheath between a conventional slotted liner and a gravel-confining screen. Mechanical handling of these liners entails no more problems than are encountered with conventional liners, which may be an advantage over flow-pack liners in some cases. The prepack gravel thickness is limited by the diameter of the water string, which in turn has been restricted more in recent years by the steel shortage, as well as by the cost of larger pipe. This often limits the screening effectiveness of prepacks and may influence the decision in favor of the flow-pack type.

The flow-pack liner, while listed last, is not the least important by any means,



Acidizing to break down the formation and provide flow channels for production to reach the bore hole is an important completion auxiliary. Large volumes of inhibited acid, forced into the producing zone under pressures above those naturally at the bottom of the well, must be accurately placed and utilized to obtain maximum benefit.

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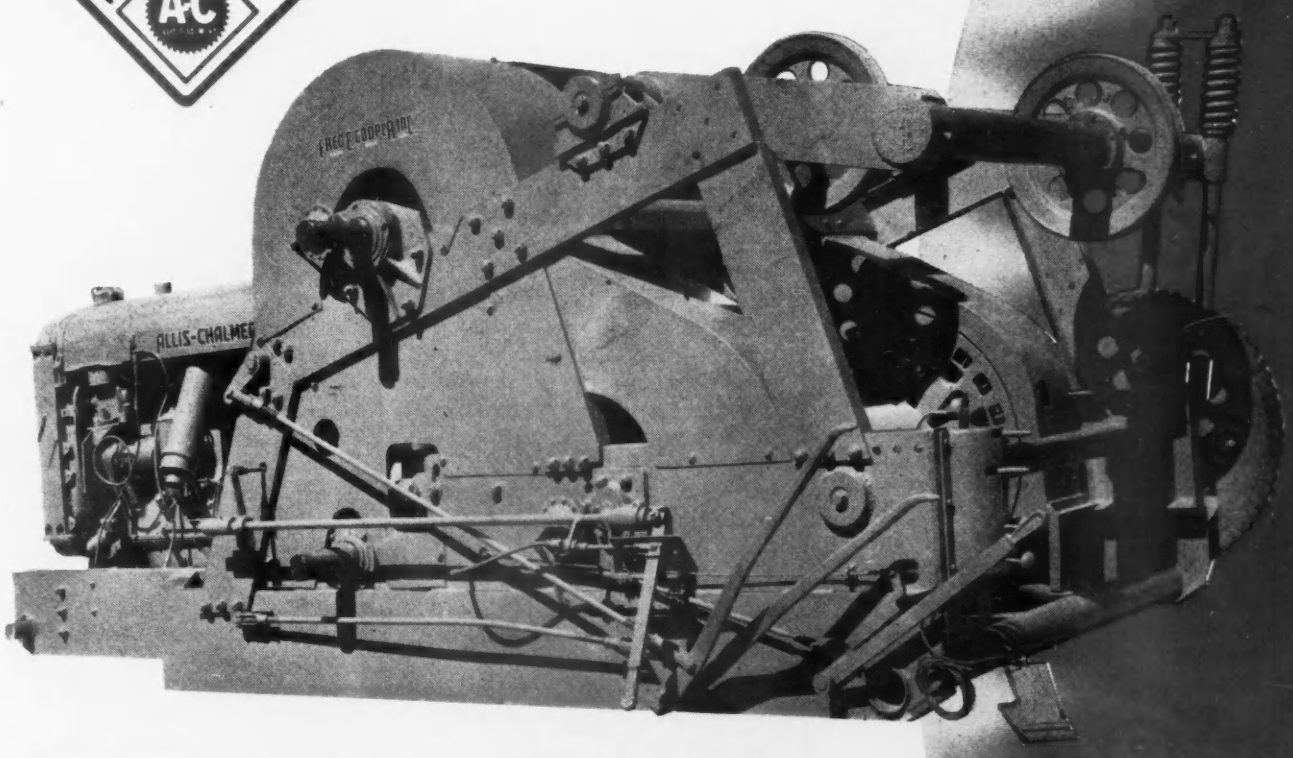
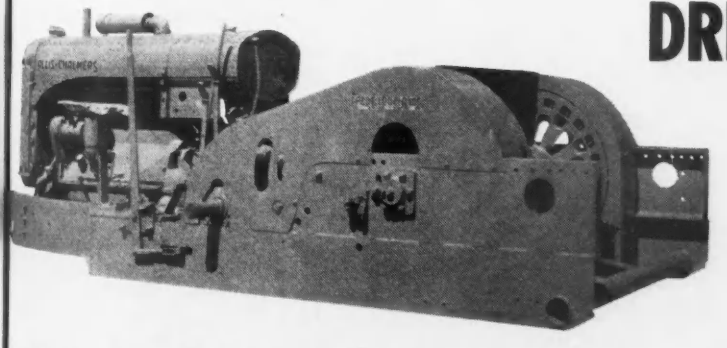


Model E-563 for SERVICING to 7,000′ DRILLING to 4,000′



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as it is considered by some to be the best for screening the finest material. The use of this type has slowly and steadily increased due to consistent progress in gravel-placement techniques and in gravel-size selection. Today thicker zones can be packed with better chance of success than a year ago, and much better than ten years ago. Gaps in the pack are less likely to occur. Flow packs hold up the formations, which is especially important in unconsolidated material, or where fractured, broken, or hydratable shales are included in the zones penetrated. Gravel beds which are thick enough for efficient screening can be used, even where small water strings have been run. In the latter case, underreaming can be used to enlarge hole diameters, when necessary.

COMPLETION TIME: Completion time, in keeping with the preferred usage of the term "completion," is considered as the period between initial penetration of the uppermost oil sand to be produced in a given well and the first settled production from the well. This may be one of the most important considerations in completing a well, as data correlating production with completion time indicate greater production is obtained from reducing over-all completion time.[1]

Regardless of how nebulous some aspects of completion time may seem, they should be considered carefully. Some or all harmful effects to production, such as loss of mud or filtrate to the formation, toughening and thickening of filter cake, mud gelling, or other harmful effects might well be more harmful if prolonged. While the careful selection and application of fluids might reduce, or counteract these effects, decreasing the exposure time certainly should prove beneficial.

Completion time should be speeded up whenever no serious consequence is anticipated. In other cases, the value of reducing the time should be balanced against any speed-up hazard which might be incurred. Often development programs as planned offer no incentive to the crews for reducing completion time. This factor and the lack of realization of the probable beneficial effects undoubtedly have contributed to delay, added cost, and reduced production.

Careful timing of the various completion phases involves selection of tools and techniques, chosen with minimum time as an objective, without neglecting consideration of operational advantages and disadvantages.

DRILL-IN TECHNIQUES: The selection of drill-in tools and techniques relates to completion time and to three factors which affect production directly: hole size, pressure imposed on the formation and the impact of the drilling tools upon the formation.

Hole size is an important consideration as regards drainage ease and annular area. While wall scraping can be used to enlarge hole diameter, this expedient must be evaluated from the cost angle, as well as from the standpoints of prolongation of completion time and mechanical hazard, before the best decision may be reached. Some of these selections must be based on such offset data as may be available.

PRESSURE EXERTED ON PRODUCING FORMATION: Another consideration closely associated with drill-in techniques is the desirability of reducing the hydrostatic head of the hole fluid to lower the net pressure exerted upon the formation. Decreasing the net pressure will minimize the harmful effects attending fluid infiltration. To this end, the simplest expedient in rotary drilling is to reduce the fluid density, although this has practical limits which can only be applied in zones with known formation pressure.

Some additional pressure reduction may follow changes in drilling practice, such as lowered mud-pump pressure, use of reverse circulation, or the no-circulation drilling and swabbing technique used upon occasion. Cable tool drilling has been suggested and used recently to reduce pressure.[2] This would also reduce to some degree the impact of the drilling tools on the formation.

Rotary drilling entails whipping or thrashing of the drill string which is a factor in consolidating and hardening filter cakes and in forming plaster cakes. Possible improvements, aside from the fluid used, involve the use of lighter pipe and drill collars, less rotational speed, and adjusted drill pipe load to minimize horizontal movement opposite the pay. There is also an effect from the vertical movement of tools in both cable and rotary drilling. These considerations can not be fully treated, as space is lacking to prolong their discussion here. However they undoubtedly deserve study.

About the Author

CARROL M. BEESON earned a B.A. degree from UCLA in 1935 and a Ph.D. degree from Cal Tech in 1938. For the following nine years he worked for General Petroleum Corporation, most of the time as supervisor of the Production Research Division. Since early 1948 he has been associate professor of Petroleum Engineering at USC. An active member of the AIME, ACS, and API, he serves the latter in several offices, including national chairman of the Subcommittee on Core Analysis and Well Logging, and now as a member of the Executive Committee of the Central Committee on Drilling and Production Practice.

Conclusion

Data needed and the relationship of the data to completion programs have been discussed in this issue. Increasing emphasis on completions has been coupled with consideration of the possible damage to the productivity of the well which should be avoided or counteracted. Completion planning, to be effective, needs comprehensive coring which is statistically analyzed and correlated with logging and survey data.

The completion program for a specific well must fit in its entirety with the ever changing overall plan for the lease or field. Individual completion plans depend upon coring, logging, and survey data, to determine the formations to be produced and their character, which in turn is related to the materials, tools and techniques to be selected. Excluding completion fluids and washing programs which will be discussed in Parts 2 and 3, the materials, tools and techniques mentioned include cementing, liner or screen selection, completion time, pressure imposed on the producing formation, and the drill-in techniques.

Summary

In this article attention has been directed to the importance of the completion stage of the well's history and the value of careful choice of materials, tools and techniques for use therein. This is the first of a series of four articles in which some of the basic considerations have been reviewed in their more general aspects.

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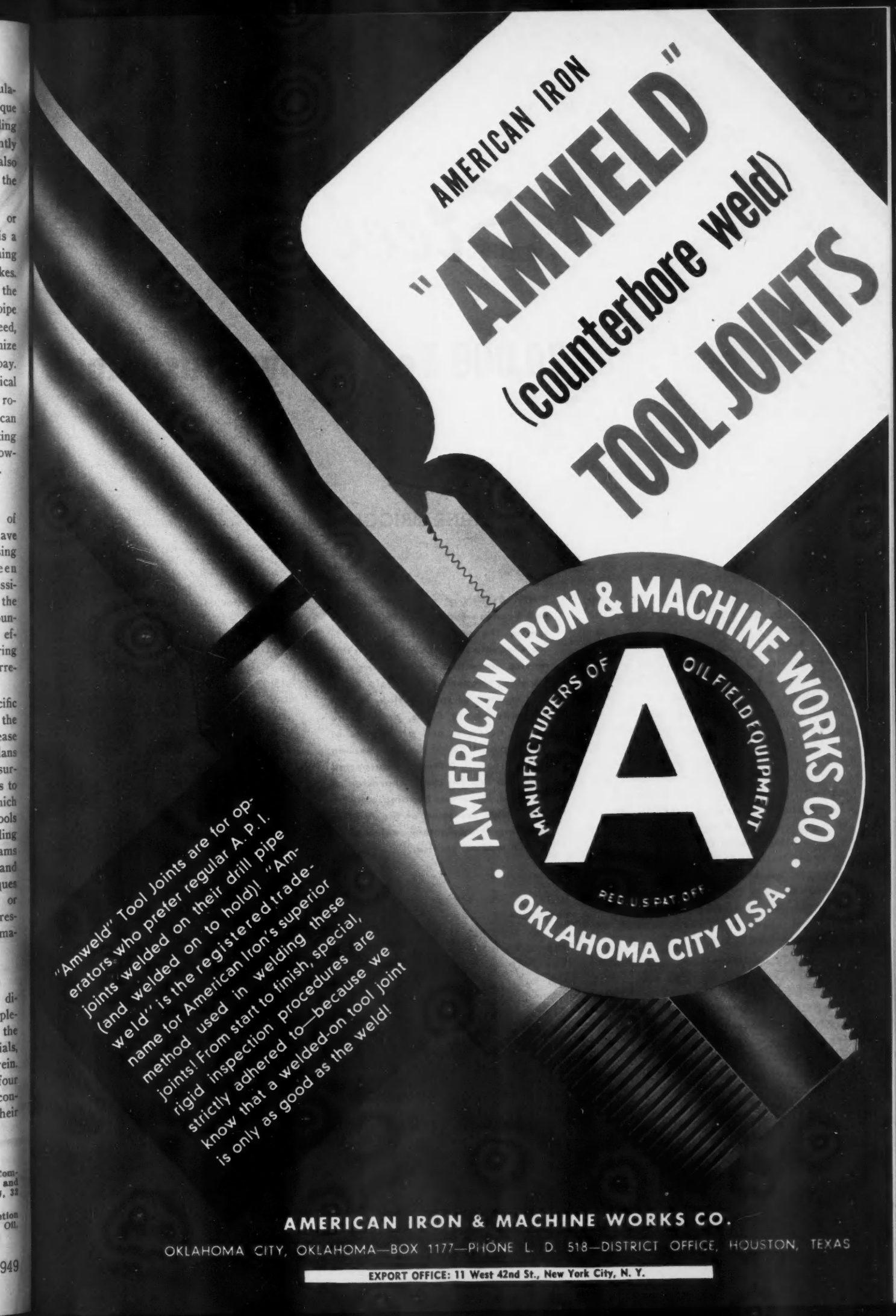
[1] Wade, F. R., "The Evaluation of Completion Practice from Productivity Index and Permeability Data," Oil Weekly, 125 (12), 32 (1947) May 19.

[2] Reynolds, J. M., "A Well Completion Technique for North Louisiana," World Oil, 129 (1), 102 (1949) May.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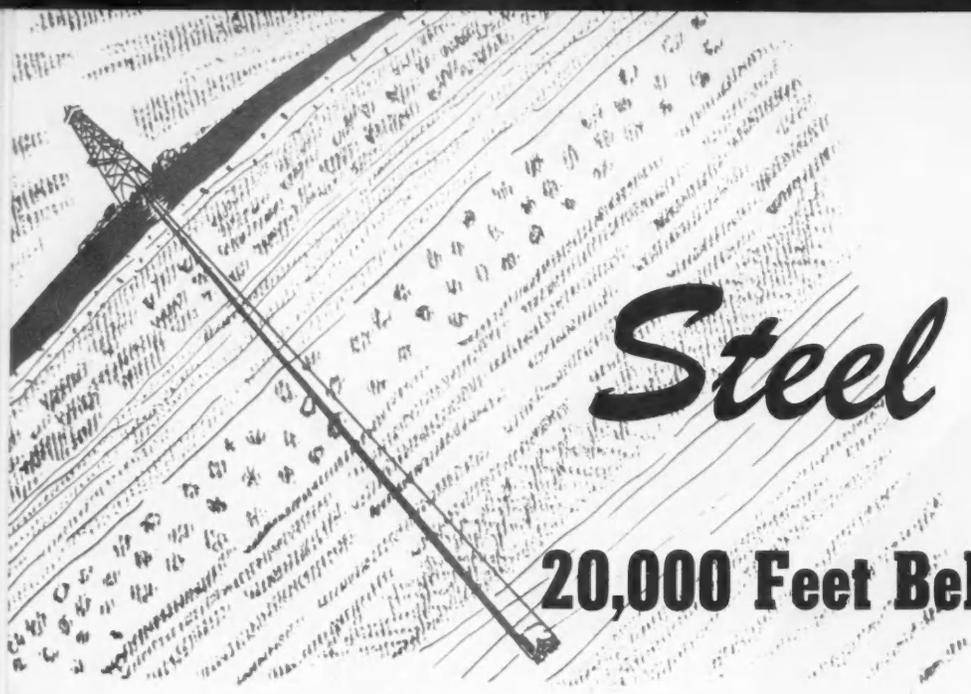


Steel

20,000 Feet Below Grass Roots

By FRANK BRIGGS

WHEN DESIGN of oil country goods had been perfected for 20,000-foot service, the next horizon for providing adequate strength for tools in this service lay within the metallurgy of the steel composing such tools. A recent method of specification, known as hardenability limits, assures the proper hardness and physicals at critical points within the cross section of the tool. A hitherto unsuspected defect in the structural character of the steel, known as banding, may be responsible for some of the failures occurring in equipment subjected to severe drilling service.

YESTERDAY'S plans for deep drilling are no longer conjecture; the 20,000-foot depth barrier has been as easily bridged by the drilling rig as the sonic barrier by the speed of the jet aircraft. In the Green River Basin of Sublette County, Wyoming, the world's present deepest well has been drilled below the 20,000-foot horizon. In order to accomplish this feat, not only a new, larger, revolutionary drilling rig was required, but a myriad of lesser equipment and drilling problems had to be solved. For instance, a record breaking string of 7-inch casing was set at 19,765 feet with a total weight exceeding 297 tons. In order to provide the necessary tensile strength, the steel in this casing was an expensive alloy type designated as SAE 4340; it was equipped with especially designed joints with extra strong, extreme line-type threads.

The pipe represents only one problem: drilling lines, derrick, tool joints, safety joints, and all types of equipment embodied in deep drilling operations automatically become critical. The service they are subjected to extends their physical characteristics to the utmost. Although design enters into the problem, limitations in that direction are at once apparent; the steel from which these tools are made becomes the most important factor and a new metallurgical horizon must be opened to the industry. Not only is composition of the steel important, but the heat treatment and the associated phases of quenching also determine the ability of the steel to perform in the severe service of deep drilling.

The average oil field personnel's knowledge of steel is generally limited. The petroleum engineer, the geologist and other supervisors have even less opportunity to investigate the importance of proper steel in the equipment they use. It is intended herein to describe briefly applicable elemental mechanics of steel composition and heat treatment. It is further intended to present typical examples of failures in this equipment and some means whereby these failures might have been prevented.

Steel Composition

Perhaps one of the oldest misconceptions reposing in the mind of the user of oil field equipment is that failure occurs occasionally through a process termed "crystallization." The failure of metals through fatigue reveals the crystalline structure at the open rupture, thus the failure acquires its name. When steel, or any metal, is poured from its molten state into ingots or other molds, the solidification accompanying the cooling process is crystallization; the steel is "crystallized" from its very beginning. When solidification starts, various "islands" of crystals form as centers for additions of crystalline growth; polygonal networks are created, much in the same manner as fungi or similar bacterial cells, until the whole mass is stable and the free development of external form is arrested.

Properly, steel is a pure alloy of iron

TABLE 1
S.A.E. Steels

Type of Steel	*Numerals (and Digits)*
Carbon Steels	1xxx
Plain Carbon	10xx
Free Cutting (Screw Stock)	11xx
Manganese Steels	13xx
Nickel Steels	2xxx
3.50% Nickel	23xx
5.00% Nickel	25xx
Nickel-Chromium Steels	3xxx
1.25% Nickel, 0.60% Chromium	31xx
1.75% Nickel, 1.00% Chromium	32xx
3.50% Nickel, 1.50% Chromium	33xx
Corrosion and Heat Resisting	30xxx
Molybdenum Steels	4xxx
Carbon Molybdenum	40xx
Chromium-Molybdenum	41xx
Chromium-Nickel-Molybdenum	43xx
Nickel-Molybdenum; 1.75% Nickel	46xx
Nickel-Molybdenum; 3.50% Nickel	48xx
Chromium Steels	5xxx
Low Chromium	51xx
Medium Chromium	52xxx
Corrosion and Heat Resisting	51xxx
Chromium-Vanadium Steels	6xxx
1% Chromium	61xx
Silicon-Manganese Steels	9xxx
2% Silicon	92xx

FIGURE 1. A photograph of the cross-section of a typical fatigue failure clearly shows the crystalline structure of the metal at the rupture and is characterized by the smooth, half-moon portion that indicates the original location of the fatigue crack.

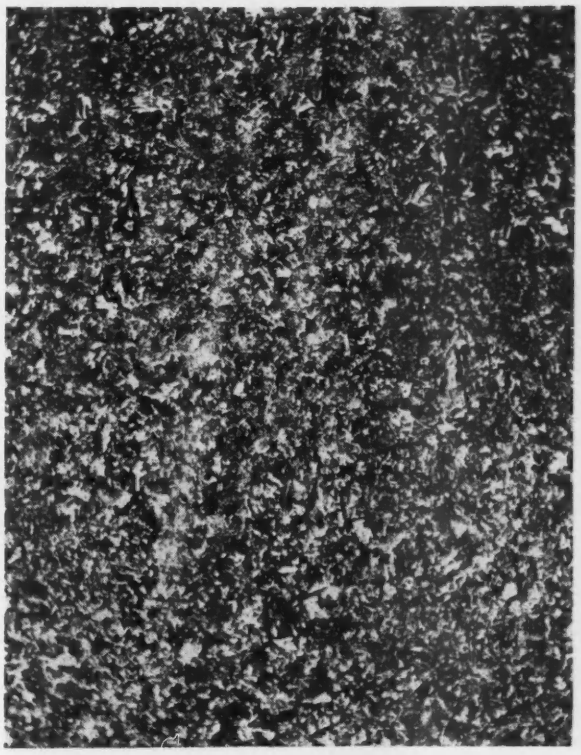


FIGURE 1A. The crystalline nature of the steel after the specimen has been etched with 5 percent Nital solution, polished and photographed at 100 diameters magnification. The white clusters are indicative of an excess of free ferrite out of solution.

and carbon; it ranges from low carbon or mild steel (with a carbon content not exceeding 0.10 percent) to high carbon or extra hard steel (with a carbon content of 1 percent or greater). The microstructure of low carbon steel shows a constituent of carbonfree iron known as ferrite; steels having greater proportions of carbon show lesser amounts of ferrite in their internal structure. High carbon steel obtains its hardness from the larger amount of constituent carbon causing a process known as carburization (cementation) to occur.

The alloy steels in the manufacture of oil country goods are those containing nickel, manganese, tungsten, chromium, vanadium, silicon, molybdenum, or combinations of these alloys. Each of the various alloys composing the steel lends properties which are desired in the final product. Such properties may be strength, ductility, impact resistance, machine ability, ability to resist such external forces as corrosion, and others. These alloy steels have been standardized in their composition and a numeral index system has been devised to make it possible to specify a certain type of steel on shop drawings without writing its chemical composition. The specifications as designated by the Society of

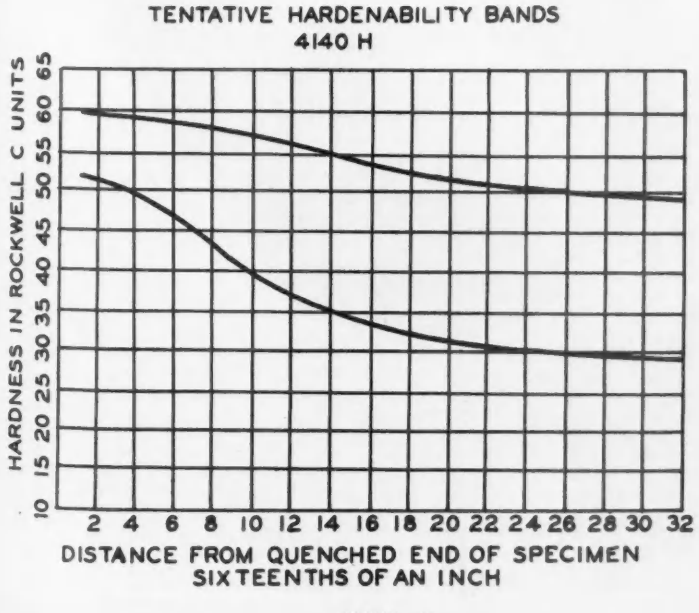

TENTATIVE HARDENABILITY BANDS
4140 H
HARDNESS IN ROCKWELL C UNITS
10 15 20 25 30 35 40 45 50 55 60 65
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
DISTANCE FROM QUENCHED END OF SPECIMEN
SIXTEENTHS OF AN INCH

FIGURE 2

TENTATIVE HARDENABILITY BANDS

Method B-B	*Color Code*
1. Carburizing Carbon Steel	
10-30 Rc @ 8/16" and maximum 20 Rc @ 2"	White
2. Medium Carbon Steel	
20-40 Rc @ 5/16" and maximum 25 Rc @ 2"	Green
3. Carburizing Alloy Steel	
20-35 Rc @ 8/16" and maximum 30 Rc @ 2"	Yellow
4. Medium Carbon-Alloy Steel	
43-58 Rc @ 8/16" and maximum 48 Rc @ 2"	
A. S.A.E. 4140	Blue
B. S.A.E. 3140	Red

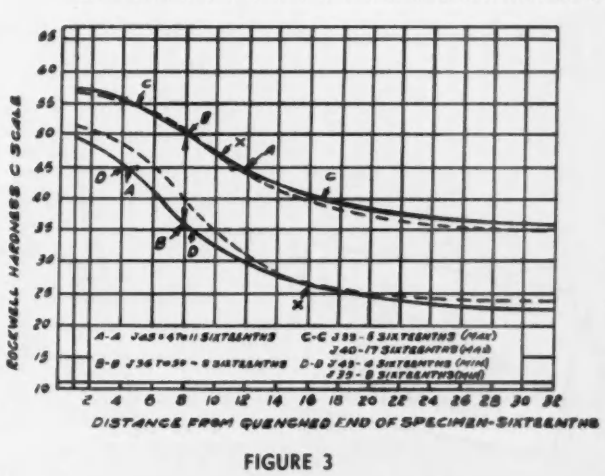
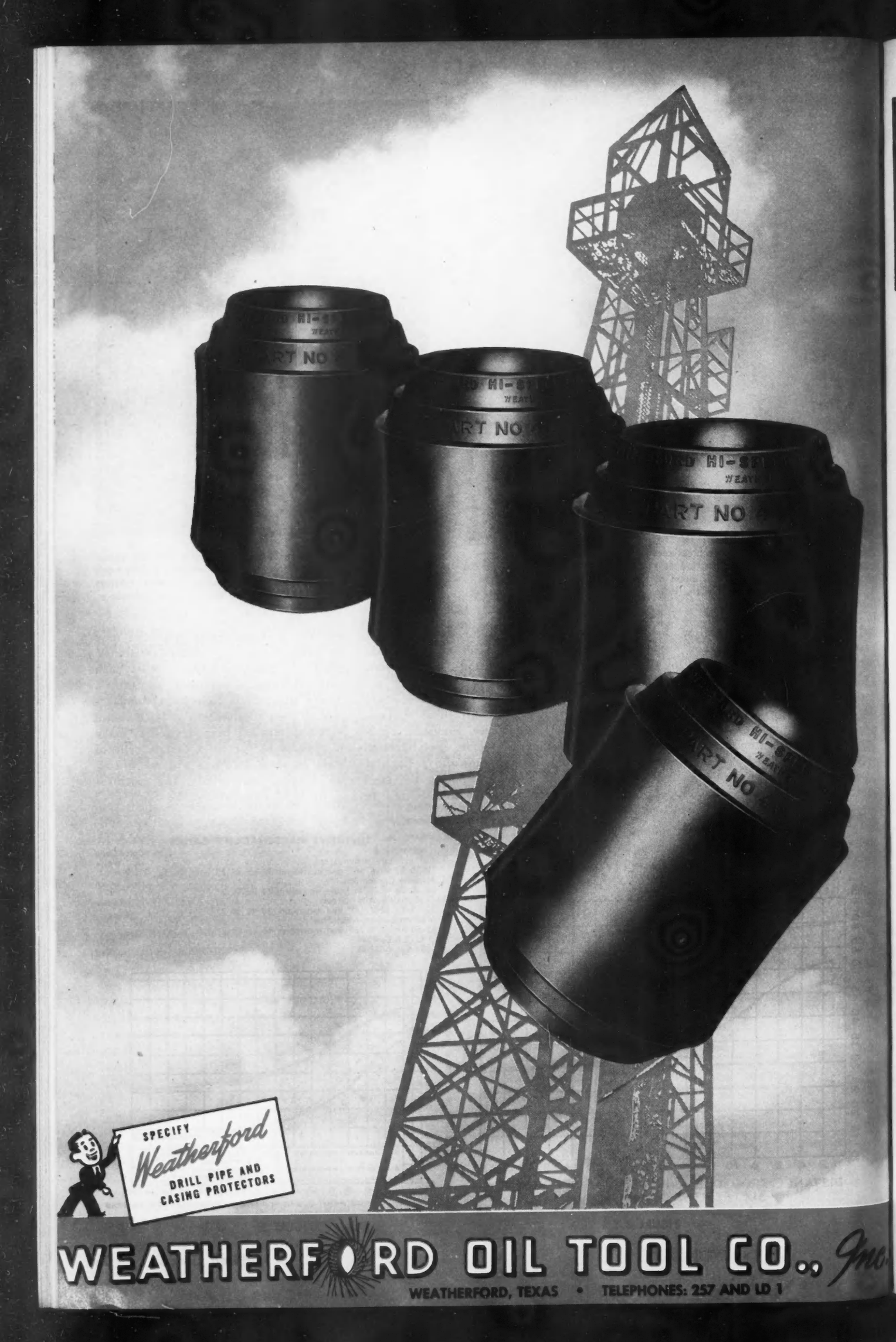


FIGURE 3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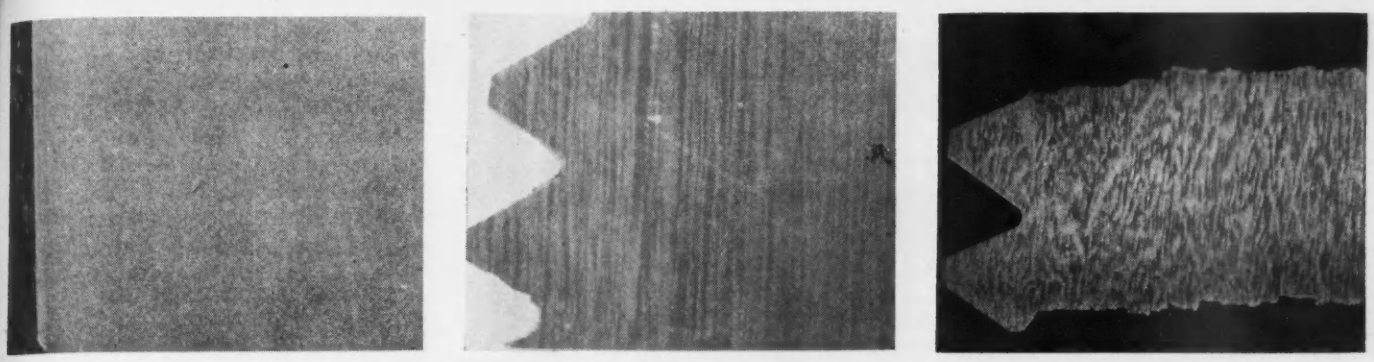


FIGURE 4. Photomacrographs enlarged five times show first an example of good quality, homogeneous steel; steel banded but of medium quality; and finally an example of rejectable, badly banded steel.

Automotive Engineers are shown in Table 1. Briefly the system works thus: the first digit indicates the type to which the steel belongs (1- indicates a carbon steel, 2- a nickel steel, 3- a nickel-chromium steel); in the case of the simple alloys the second digit indicates the approximate percentage of the predominating alloy. Usually the last two or three digits indicate the average carbon content in hundredths of one percent. For instance, SAE 4340 is a molybdenum steel (4) with approximately 0.03 nickel (3) and approximately 0.40 percent carbon (40).

The American Iron and Steel Institute has a similar system of identification for steels that closely parallels the SAE designations. Where the prefix letter "A" is used before the series, the steel is basic openhearth alloy; "D", acid openhearth steel; "E", electric furnace. Where the suffix letter "H" is used, the steel is specified according to hardenability band limits.

Heat Treating

In heat treating steel, the object is to secure, through action of heat, certain desired physical properties. These properties are obtained because of the internal structural changes induced by heat. It should be remembered that the resulting physical properties of steel do not depend alone upon the chemical compositions and the microstructure, but also upon the macrostructure (which is determined by heat treatment) as well. All grades of steel, when heated to a certain high temperature (critical), become a solid solution of carbon or of the carbide of iron. At this stage, the character of the steel is known as austenite. Upon cooling, either fast or slow, the character of the steel again changes and the constituents in progressive cooling stages may be known as martensite, troostite and sorbite. Each of the constituents has its own physical properties which it imparts to the steel. Martensite is the hardest, strongest and least ductile; it is obtained through very rapid cooling after heating. Troostite and sorbite are less hard, less tenacious and more ductile and correspond to more advanced stages of the transformation.

Because of the definite transformations occurring in steel during heat treatment, it is possible to predict and obtain the exact desired hardness and strength in steel products. Regardless of the type of steel used, there is a very definite relationship between the tensile strength and the hardness to which it has been heat treated. This relationship is shown in Table 2.

Steel Specifications

Although drilling has always taxed the ability of equipment to perform, the deeper service to which it is now subjected will require the strict adherence to specifications for the right steel to go into those products. One of the newer specifications in the control of physical properties of steels is that known as "hardenability bands." This specification utilizes the hardening ability of a steel when heat treated and quenched. The resulting hardness will vary proportionately from the outside surface, where the quench was most severe and the cooling rate the greatest, to the inner core where the reaction from the quench was cushioned by the mass of metal itself. The "end-quench hardenability test" ranks as one of the greatest contributions to the science of metallurgy because of its importance to both the steel user and the manufacturer. The procedure consists of quenching a previously heated bar one inch in diameter and two inches in length. The quench medium is a fine spray of water applied to one end only. A hardness survey is made over the entire length of the bar after quenching.

By plotting the hardness (in Rockwell "C" units) of the test specimen against the distance of the hardness determination from the quenched end, typical hardenability bands (Jominy curves) are obtained. A maximum and a minimum curve form the "bands" and acceptable steel must have characteristics lying within these limits. Such typical hardenability bands for the common oil field steel of 4140 H are shown.

To illustrate the advantage of such specifications, consider a safety joint. Without purchasing steel under hardenability ratings, this tool may have the desired hardness range of 285 to 321 Brinell at some point on its outside diameter. After the metal has been machined away to make threads, a lesser hardness (and thereby weaker) point in the cross section of the body is obtained. The thread is a critical point and to prevent galling and maintain adequate strength, a desired hardness should prevail. If the steel is purchased under hardenability specifications, the manufacturer knows the approximate hardness (after heat treating) from the outside surface to the inner wall of the product, thus the desired hardness and strength at critical

TABLE 2
Hardness and Tensile Strength Coordination

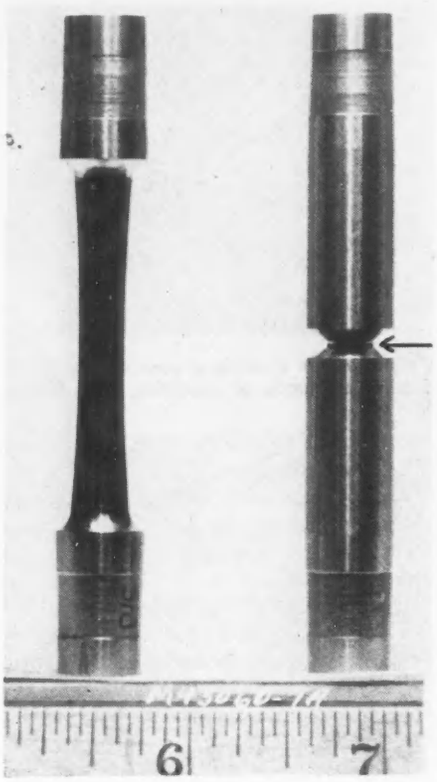
Rockwell C (C) 150 Kg Load	Brinell 3000 Kg Load—10 MM Ball	Tensile Strength 1000 Lbs. Per Sq. In.
52	538	273
51	523	264
50	508	256
49	494	246
48	479	237
47	465	231
46	452	221
45	440	215
44	427	208
43	415	201
42	405	194
41	394	188
40	385	181
39	375	176
38	365	170
37	356	165
36	346	160
35	337	155
34	329	150
33	319	147
32	310	142
31	302	139
30	293	136
29	286	132
28	278	129
27	271	126
26	264	123
25	258	120
24	252	118
23	246	115
22	241	112
21	236	110
20	231	107
19	226	104
18	222	103
17	218	102
16	214	100
15	210	99
14	206	97
13	202	95

sections, such as threads, can be maintained.

A typical specification for the purchase of steel by the hardenability band method is shown. It should be pointed out that the chemical composition of the steel is neglected (except in broad designations) and physical properties are completely ignored—as long as the hardenability limits are maintained. This illustrates the complete tie-in between hardness and the other physical characteristics of the steel. For instance, for the alloy steel of 4140 (the band limits shown on Figure 2) the specification would read simply "Steel having a hardness of 43 minimum to 58 maximum Rockwell 'C' units at 8/16-inch distance from the quenched end and the hardness not to exceed 48 Rockwell 'C' units at a distance of 2 inches."

Banding

Banding in steel is a structural phenomenon, the effect of which upon its strength has not yet been determined. No specifications for banding have been set up by any organization or steel mill;



the question is handled much in the same maner as the effect of tobacco upon the human body — no definite detrimental evidence, but do without it if you can. The case against banding is primarily based upon metallurgical examination of a number of failures in oil field equipment. This equipment includes safety joints, subs, and drill collars; in each case, failure occurred in heavily banded steel stock. Of course, it is not known whether these failures would have occurred had the steel been free of banded structures. Typical examples of steels free from banding, steels not excessively banded and steels with heavy banding are illustrated.

The varying opinions of banding in steel stem from its peculiar nature. Some mills claim that this structural characteristic may be completely eradicated through selective heat treating. In some steels this is true, and in others

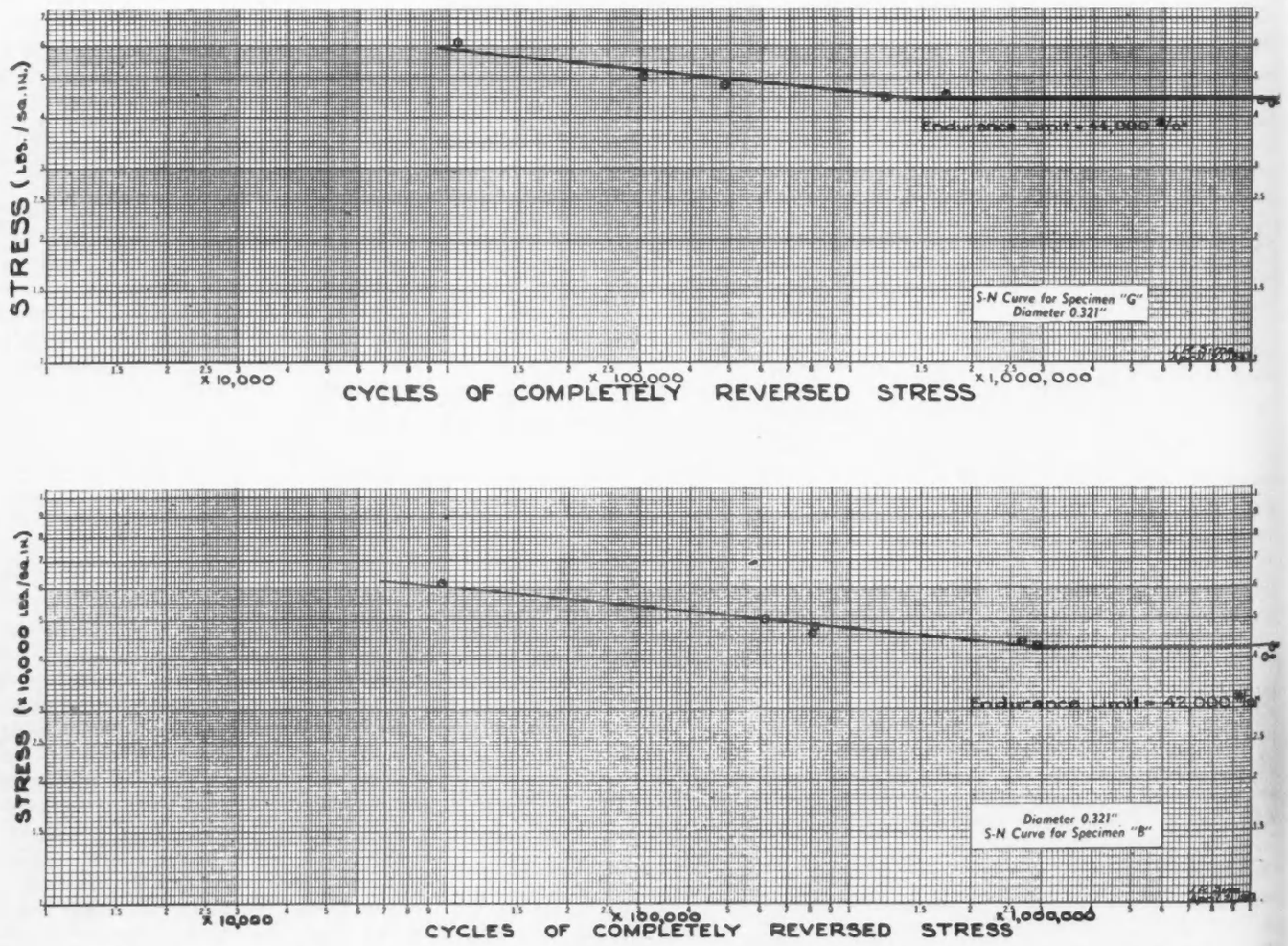


FIGURE 5. Using specimens machined as shown in top photo, the S-N curves were obtained for badly banded and good quality steels. A comparison of the endurance limits of these steels indicated a difference of 2000 psi.

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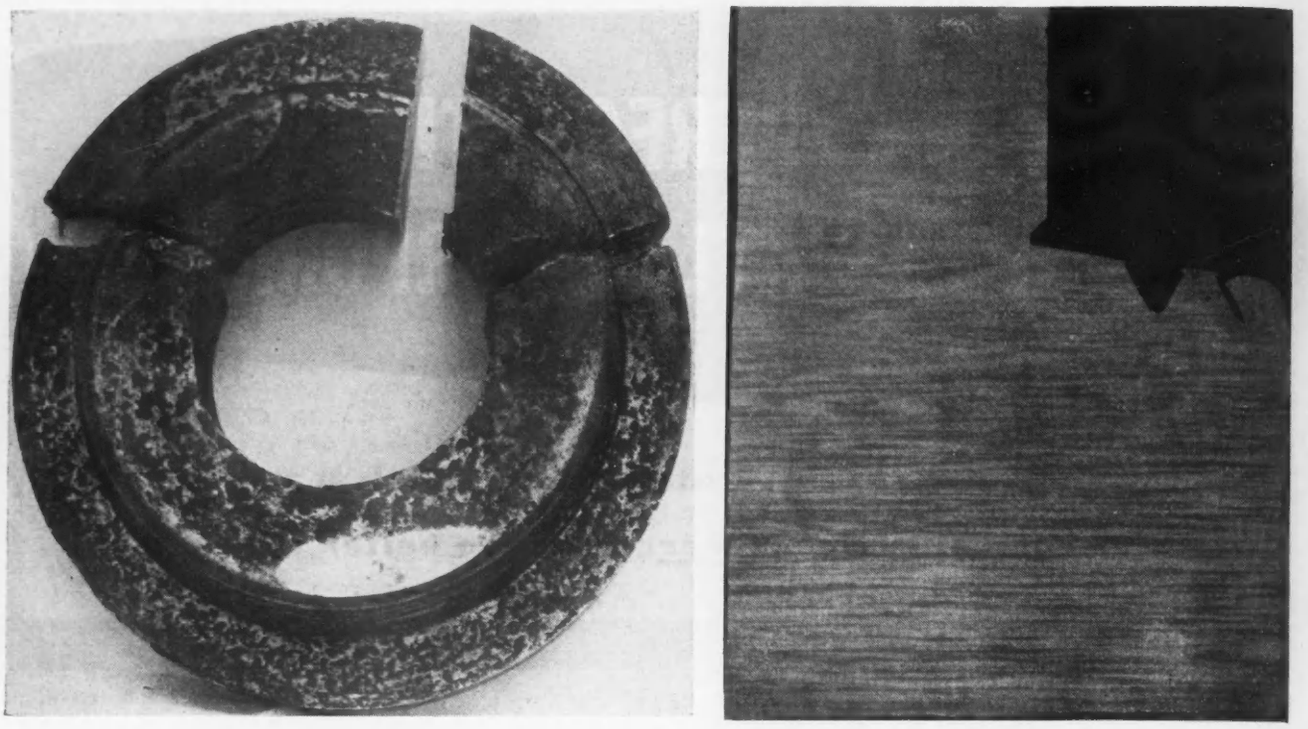

FIGURE 6. A photograph of a sub that failed in service (left), shows no indications of excessive fatigue. The smoothness of the rupture indicates that the driller failed to cease operations when the fracture occurred. A photomacrograph, of a polished and etched section of this sub, magnified by three, shows heavy banding.

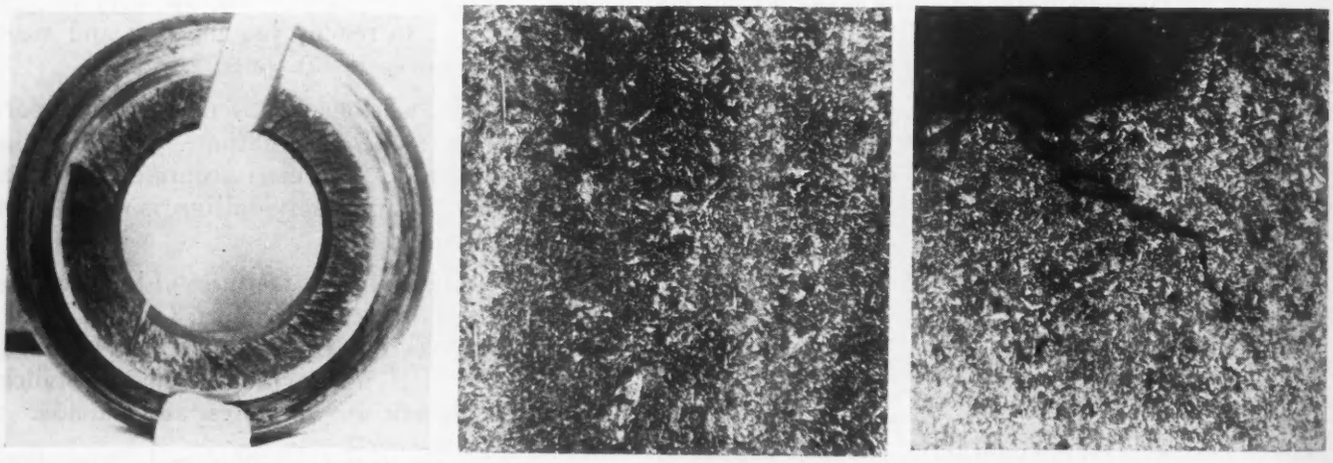

FIGURE 7. Another sub failure is shown above; the absence of fatigue is also indicated in this fracture. Taken at 100x magnification, a photomicrograph of a polished and etched specimen shows the characteristic streaks of banding indicative of rich and lean zones of alloys. Another enlargement shows a crack originating at the surface.

FIGURE 8. The possible effects of banding upon the galling of threads and the resulting failure in service are indicated above. Banding provides hard and soft streaks which make the thread difficult to machine.

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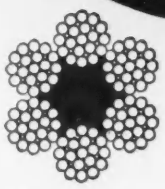
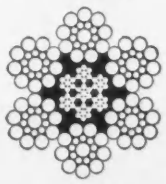
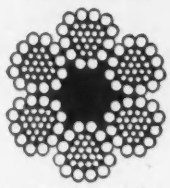


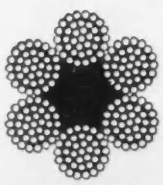
6 x 19 Filler Wire Fiber Core



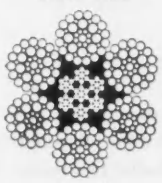
6 x 19 Seale Wire Rope Core



Style G-Flattened Strand Fiber Core



6 x 37 Filler Wire Fiber Core



6 x 41 Wire Rope Core

"HERCULES" (Red-Strand) Wire Rope has proved its worth by the accurate yardstick of actual performance. For over 60 years the Red-Strand has been a dependable guide to safe and economical wire rope service. Now in the Preformed type, a plus value has been added. As internal stresses are largely eliminated, the rope is less apt to kink . . . it is easier to handle . . . it spools better. But these are not the only advantages. Because internal stresses have been reduced there is less internal wear and more resistance to bending fatigue, which means longer life.

Another and an ever important factor in determining wire rope life is the use of the right construction for the work the rope is to do. To meet this situation, Preformed "HERCULES" (Red-Strand) Wire Rope is made in a wide range of both Round Strand and Flattened Strand constructions. There is a correct type for any heavy duty job. Our Engineering Department will be glad to help you make the right selection.

We invite your inquiries.

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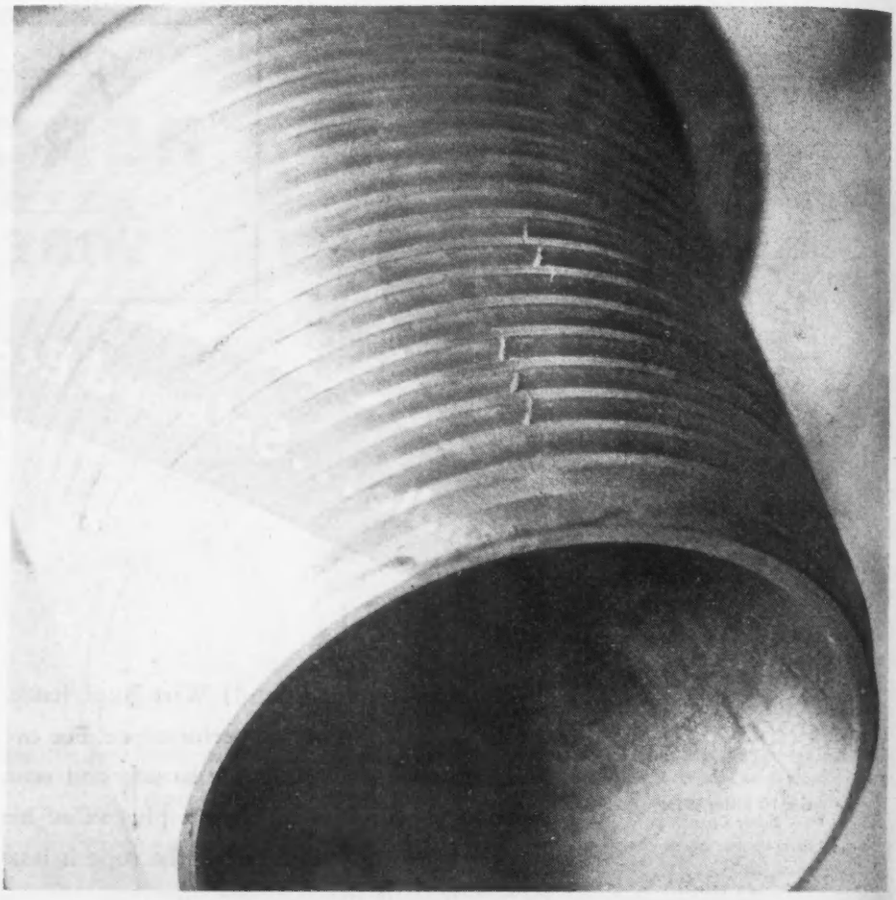

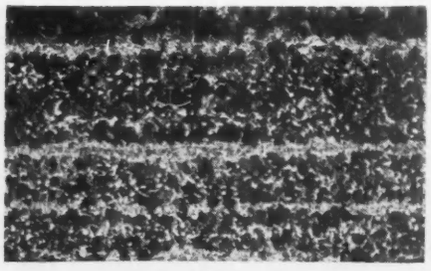

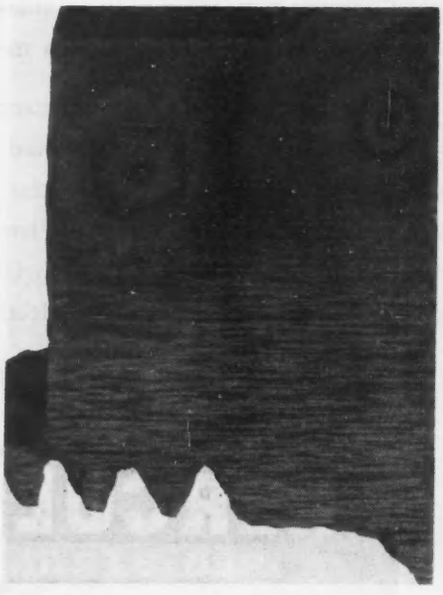

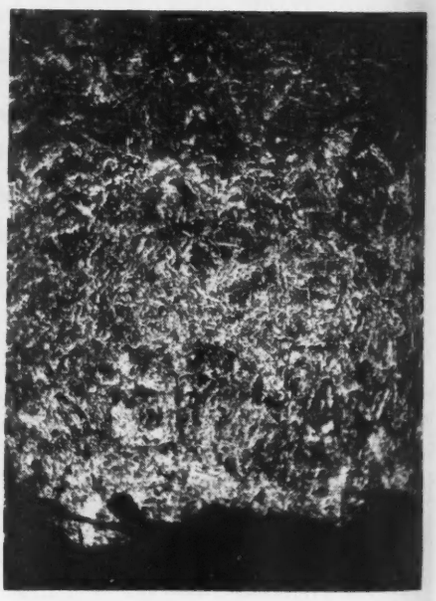

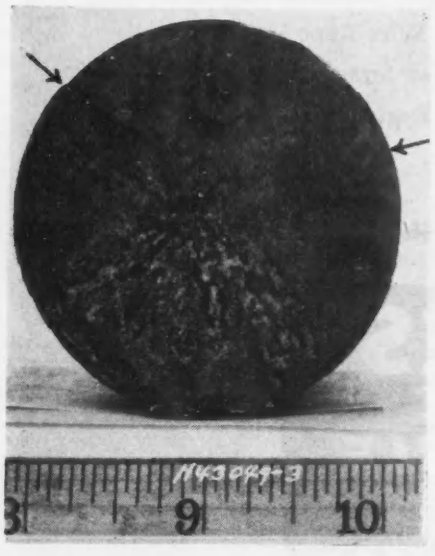

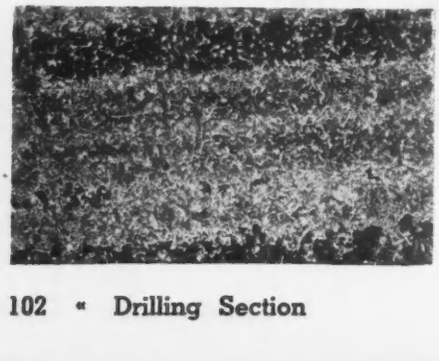

FIGURE 9 (Left Column). The fatigue failure of a mud pump rod is shown with the corresponding photomicrographs, indicative of severe banding. Specimens from this rod were subjected to fatigue testing in the polished, notched and clamped condition. Failure was attributed to stresses caused by faulty design.

FIGURE 10 (Above). Magnetic inspection discovered the two cracks shown in the drill collar. A cross-section taken from the drill collar thread failure shows banding on the outside periphery and a homogenized material on the inside. A magnification of this section shows the incomplete solution of the matrix and decarburization of the threads.

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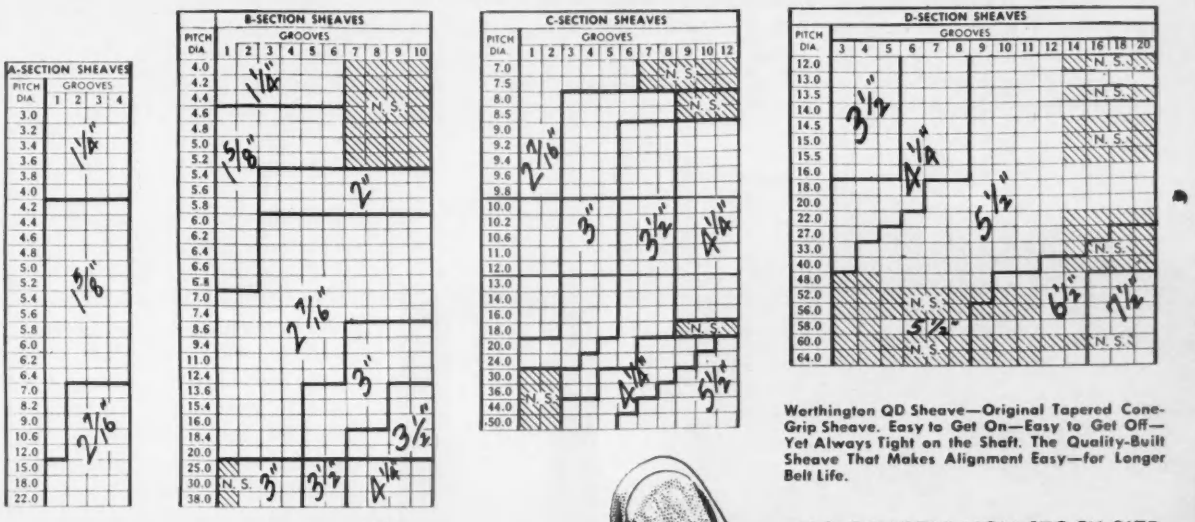
STOCK SIZES WORTHINGTON HEAVY DUTY "QD" SHEAVES WITH MAXIMUM BORES INDICATED


A-SECTION SHEAVES
PITCH DIA.
GROOVES 1 2 3 4
B-SECTION SHEAVES
PITCH DIA.
GROOVES 1 2 3 4 5 6 7 8 9 10
C-SECTION SHEAVES
PITCH DIA.
GROOVES 1 2 3 4 5 6 7 8 9 10 12
D-SECTION SHEAVES
PITCH DIA.
GROOVES 3 4 5 6 7 8 9 10 11 12 14 16 18 20
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As long as it takes our distributor's shipment to get there is as long as it takes—in most cases—to get exactly the sheave you need into your hands. Your Worthington distributor has practically any stock size you'd ever call for—if he hasn't, one of the Worthington warehouses will get it to him in 24 hours or less.

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Top-ranking distributors in the oil fields handle Worthington QD Sheaves and Worthington-Goodyear V-belts. They are backed by Worthington warehouses whose stocks duplicate the factory stock at Buffalo—more sizes stocked than any other sheave on the market. With 853 sizes in "A", "B", "C" and "D" section, ½ to 600 hp, you can fill almost any rpm requirement with a *stock* sheave. Also: 332 listed stock sizes of EC Cord V-belts.

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this has been tried and found in error. Tensile tests made of banded and unbanded structures fail to disclose any discrepancy between the two; this is possibly due to the alignment of the bands in the direction of the applied pull. Fatigue tests indicate a slight difference in endurance limits.

One particular test conducted at Rice Institute gave the results as shown on the included S N curves. The specimens for this test were standard fatigue testing shapes and one group of twenty was made from heavily banded steel and the other group of twenty was made from steel of good quality. The results of the good steel indicated an endurance limit of 44,000 pounds per square inch; those specimens of banded steel indicated an endurance limit of 42,000 pounds per square inch—a difference of only 2000 pounds per square inch. Steel mills may consider this figure insignificant, but it is possible that it may be the difference between continued service or failure of a tool when working under the severe service of deep drilling.

Fatigue tests conducted upon heavily banded structure of a drill collar that failed in service, revealed that the endurance limit for polished rotating beam specimen was within the expected range for the material of that hardness and tensile strength. The same was true for the notched specimen. Quoting this mill report, "From the data obtained, it is apparent that the effect of a 0.02 inch notch upon the endurance limit of banded SAE 8744 steel was not any greater than the effect of a similar notch of a quenched and drawn N E 9440 steel free from banding. Therefore, the effect of banding in the 8744 steel appears to be negligible as far as endurance limits of smooth and notched bars are concerned." Thus, it would appear that divergent views evaluating the importance of banding exist between the manufacturer and the steel mill. As pointed out previously, no conclusive evidence regarding the effect of banding upon the service life of steel products is available; however, several of the mills have agreed to research programs to aid in this determination. In this manner, it is possible that some new factor, hitherto undisclosed and evident only when the steel is subjected to service stresses, may be found. At any rate unbanded steel, free from any of the inclusions associated with this structure, is desirable by the manufacturer of oil country goods.

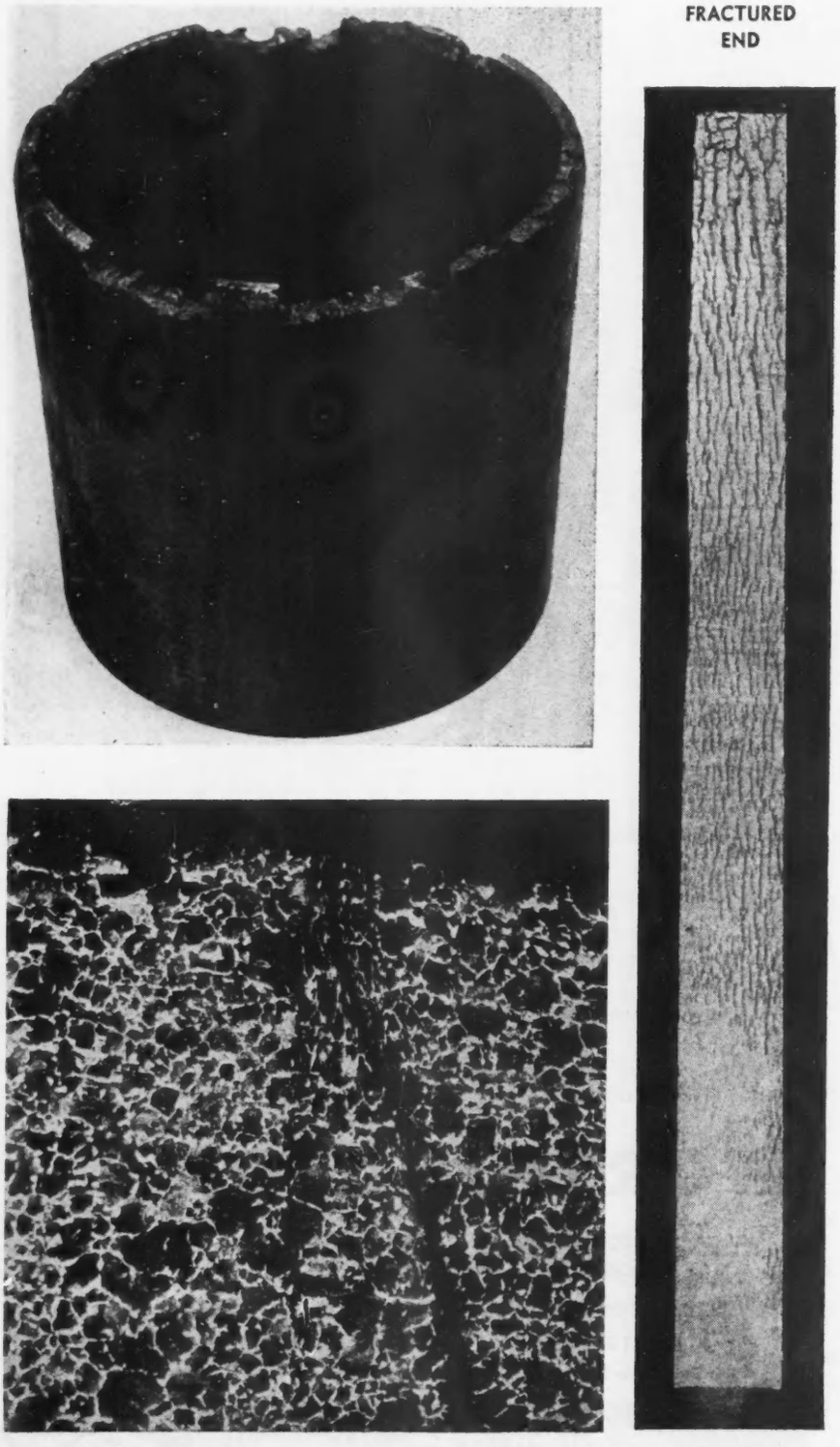


FIGURE 11. Wash pipe is often subjected to severe service due to the close tolerances on both inside and outside diameters when in service. A typical failure, probably due to the excessive generation of frictional heat, is shown. Heat checking is adjacent to the fractured end and magnification indicates cold working around the crack as shown by the distortion of the grain. Otherwise the material is normal for SAE 1040 steel.

Equipment Failures

Because of lack of evidence to the contrary, failures in various oil field equipment were suspected of resulting from the heavily banded structure of the steel from which these tools were made.

Several examples of failures in substitutes are shown. Figure 6 is a plan view of a short section of the pin of a 5-9/16-inch API full hole sub. Ultimate failure was attributed to the weakening of the steel due to the banded structure. A cross section taken through a longitudinal direction of the pin, polished and etched and magnified by three shows heavy banding.

A plan view of a 4½-inch API double pin sub failure, on which extensive testing was made, is shown in Figure 7. Test bars from this sub indicate a yield strength of 111,500 psi, tensile strength, 135,500 psi, elongation, 19.5 percent, reduction of area, 53.5 percent.

WILCOX SAND
BEE COUNTY, TEXAS

Mud (Water & Clay): R_m = 0.85 ohm at BHT
Bit Size: 8⅝"
Spacings: AM = 16"
AM' = 63"

This is the second in a series of interpreted electrical logs from identified formations and fields which Schlumberger will reproduce in this publication. If you would like to keep this entire series, please write to us on your letterhead and we will be glad to send you a reprint of this log (and the preceding log in this series) with a binder in which you may file subsequent logs as they are published. This series is made possible through the courtesy and cooperation of the oil operators who have released these logs.

LOG ANALYSIS

1) Water saturation S

Resistivity at water level R_o = 2.5 ohms in neighboring well.

At level A: $S = \sqrt{\frac{2.5}{41}} = 24.5\%$ approx.

2) Formation water resistivity R_w

With $SP = -70 \log_{10} \frac{R_m}{R_w} = -50$ mv.,

$R_w = 0.16$ at BHT

$F = \frac{R_o}{R_w} = \frac{2.5}{0.16} = 15.5$ approx.

3) Porosity p

$p = \sqrt[m]{\frac{1}{F}} = 25\%$ for m = 2

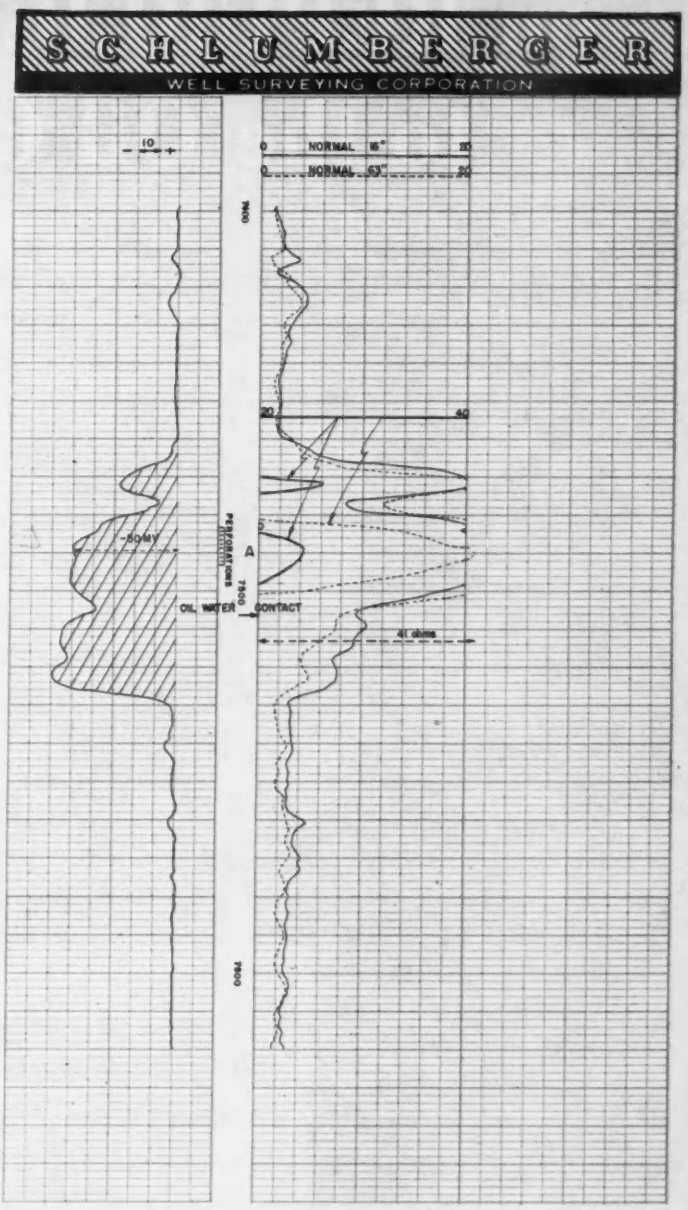
CORE ANALYSIS

Average Porosity	24%
Average Permeability	500 md.
Residual Fluids	Oil 11%
	Water 47%

PRODUCTION RESULTS

Perforated: 7483-7493 with 48 shots

Production Potential: 165 bbl. oil 42° API



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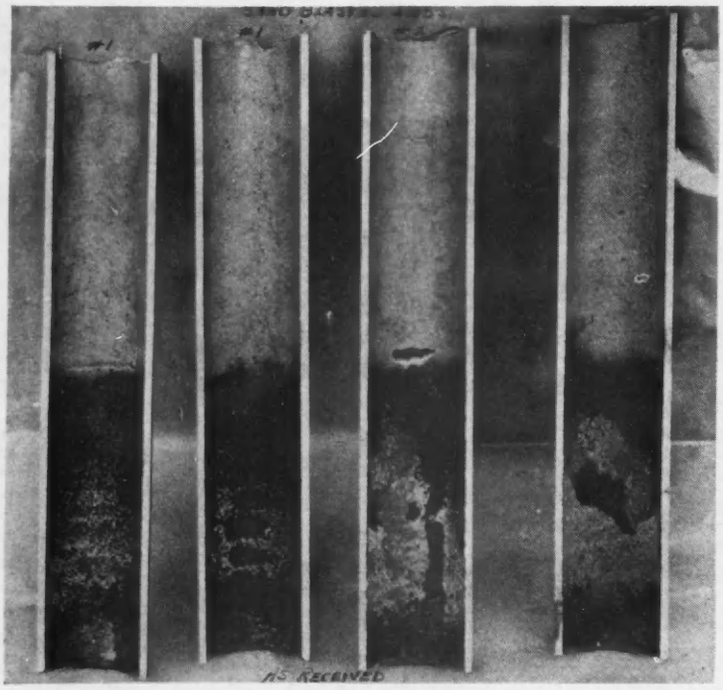


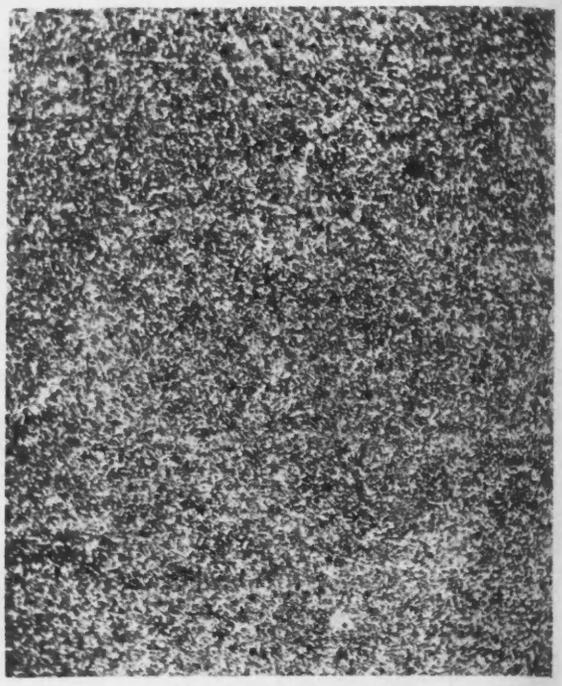


FIGURE 12. Typical corrosion fatigue failures in drill pipe are shown. Numerous cracks are evident on the sand-blasted walls of the failure specimen. Magnification of the steel in the drill pipe shows a good, homogeneous structure.

These physical properties are normal. Photomicrographs of this same failure show heavily banded structures.

A failure section of the piston rod of a mud pump is shown in Figure 9. The actual fatigue fracture is evident; no tool mark or other defect at the origin of the fracture was found, but the banded structure of the rod is prominent.

Polished specimens were made from this rod and were subjected to fatigue testing. The results indicate the standard specimen to have an endurance limit of 57,000 psi, the notch specimen, 28,000 psi and the clamped specimen, 30,000 psi. These figures seem normal for this material (which is N E 8650 steel) and point to the conclusions reached by this mill: the heavy banding in this material is negligible as far as the endurance limits of smoothed and notched bars are concerned. Failure most likely occurred from faulty design, creating excessive stress points in the rod while in service.

Drill collars are critical items which only recently have been thought worthy of care in the selection of the material from which they are made. Due to the bulky, heavy walls of the drill collar, it was previously thought that sufficient strength was inherent. Deep drilling has proven the error of this thought. Drill collar failures become excessive where steels are improperly selected. It is now known that impact values as well as hardness on the threads are of extreme importance to their service life.

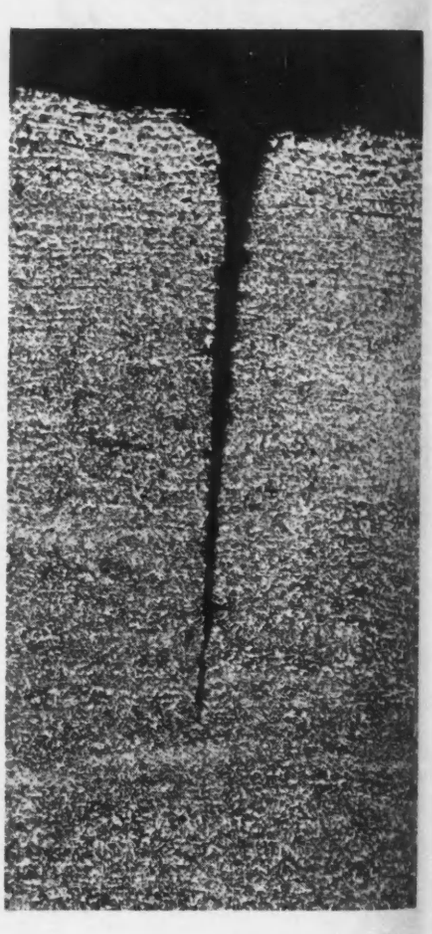
Many of the defects in drill collars are first found through the use of magnetic powder testing. Such defects as cracks, when under the influence of a magnetic field, cause fine iron powder to build up and thus reveal their presence.

A heavily banded cross sectional area of a drill collar failure, polished and etched and magnified four times, clearly shows this effect upon machining of threads. The bands represent hard and soft spots in the steel and this was verified by the lathe operator who machined the threads thereon. A structure of the same drill collar with an incomplete solid solution of the material as well as decarburization on the threads is shown.

Wash Pipe Failure

A failure sample of 6⅝-inch wash pipe is shown in Figure 11. This is SAE 1040 steel and the results of metallurgical examination clearly indicate failure due to the severe service to which it was subjected. The cracks, photographed on a section of the pipe from the inside surface, are typical of heat checks, created by the high frictional heat of one metal rubbing against another. A photomicrograph of this same section, with considerable cold working around the rupture, indicates excessive heat generated during service. It was apparent that the cause of this failure was due to localized heat checking, followed by excessive stressing which created the cracks and the eventual failure.

The subject of drill pipe failures has received voluminous attention recently and fine results have been accomplished towards extending the life thereof. Failure of a drill pipe section through corrosion fatigue is common in such areas as West Texas and the illustrations shown are typical. Preventive means lie in frequent inspection and steel selection.

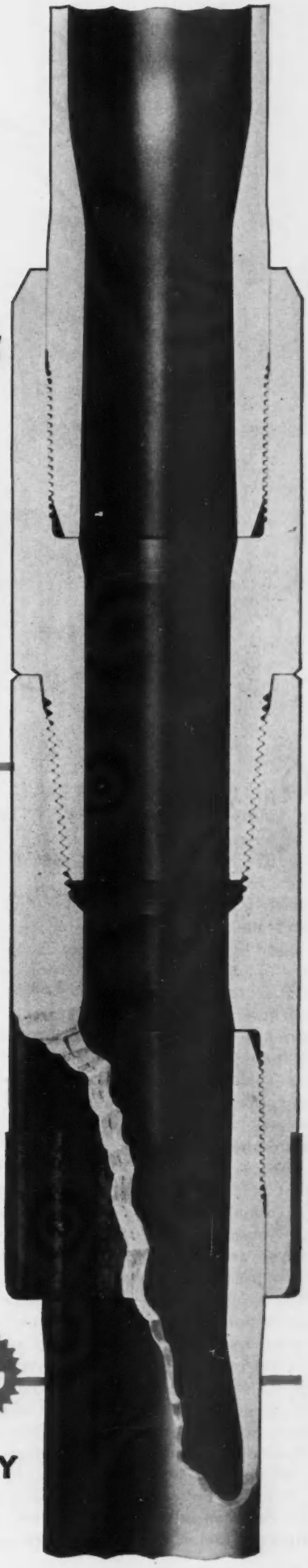


REED

Super Shrink-Grip

TOOL JOINTS

reduce drill string costs



This square landing shoulder eliminates the "human factor" in the field application of Reed Super Shrink-Grip Tool Joints. It eliminates the loose or split joints that result from inaccurate gaging.

Furthermore, it gives extra strength and rigidity and it forms a valuable third seal to protect against leakage.

But the square landing shoulder, another Reed "first", is only one of many features that make Reed Super Shrink-Grip Tool Joints the safest and most economical on the market. Ask your Reed representative to tell you about the others.

BE SAFE WITH REED

Reed ROLLER BIT COMPANY

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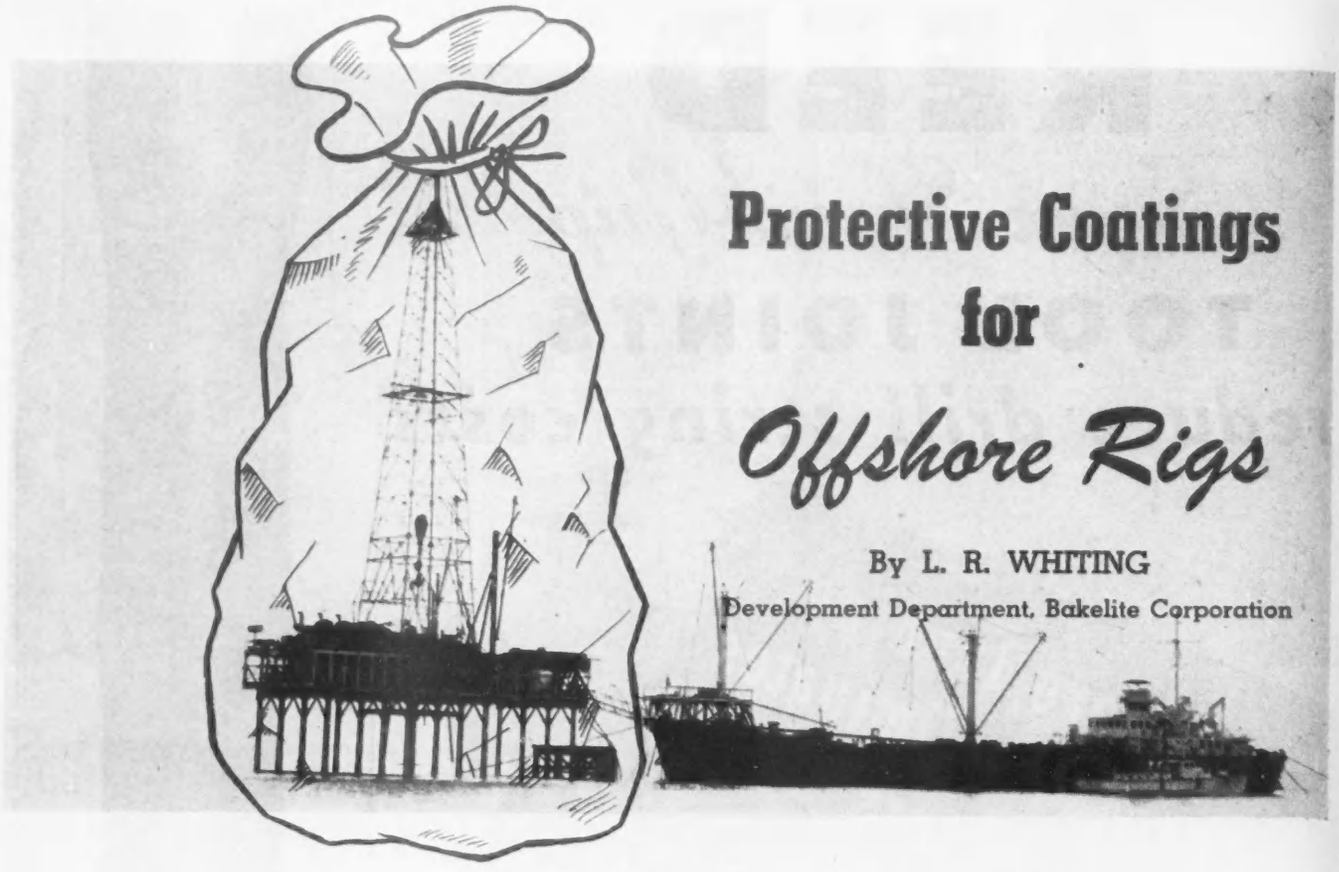


Protective Coatings for *Offshore Rigs*

By L. R. WHITING
Development Department, Bakelite Corporation

Surfaces of this offshore drilling platform are protected against the corrosive action of sea water and the abrasive action of debris by surface coatings formulated from vinylite resins.

ONE of the most severe tests of the durability of surface coatings is their use on equipment for offshore oil drilling. The corrosion problems encountered are greatly increased by the salt water which is frequently washed and blown over the equipment. Abrasion is often caused by the buffeting of floating debris and by physical contact with boats, loading or unloading.

These corrosion problems are in addition to those always encountered in drilling for and in pumping oil, such as the solvent nature of the crude itself, corrosion caused by sulfur and its compounds, and weathering by the sun and atmosphere.

Among the most successful coatings that have been used to combat the severe corrosion encountered in this equipment are those formulated with vinyl resins. These are the same resins that have been used successfully in protecting tanks, pipes, and similar equipment throughout the chemical and processing industries, as well as in other phases of the oil industry. The vinyl resins are a group of synthetic materials which are identified by the organic chemist as polymers containing the vinyl grouping of elements. Production of vinyl resins in 1948 reached an all-time high of 230 million pounds, and further increases are expected in 1949. This includes vinyl alcohol, vinyl acetate, vinyl butyral, vinylidene chloride and vinyl chloride types, with the last mentioned accounting for the largest portion of the total.

The vinyl chloride types have outstanding qualifications for use in surface coatings, although the other types are also used for special applications. Foremost among the vinyl chloride types are the copolymers of vinyl chloride and vinyl acetate. The ratio between these two compounds can be varied, as can the molecular weight of the resulting polymer, thus making the number of possible compounds theoretically infinite. Tripolymers, as well as modifications of polymers, expand the possibilities. Some of these resins are used in other well-known plastics applications, such as in molding and extrusion compounds, in rigid sheet, and in flexible film and sheeting, and all of them are used in surface coatings.

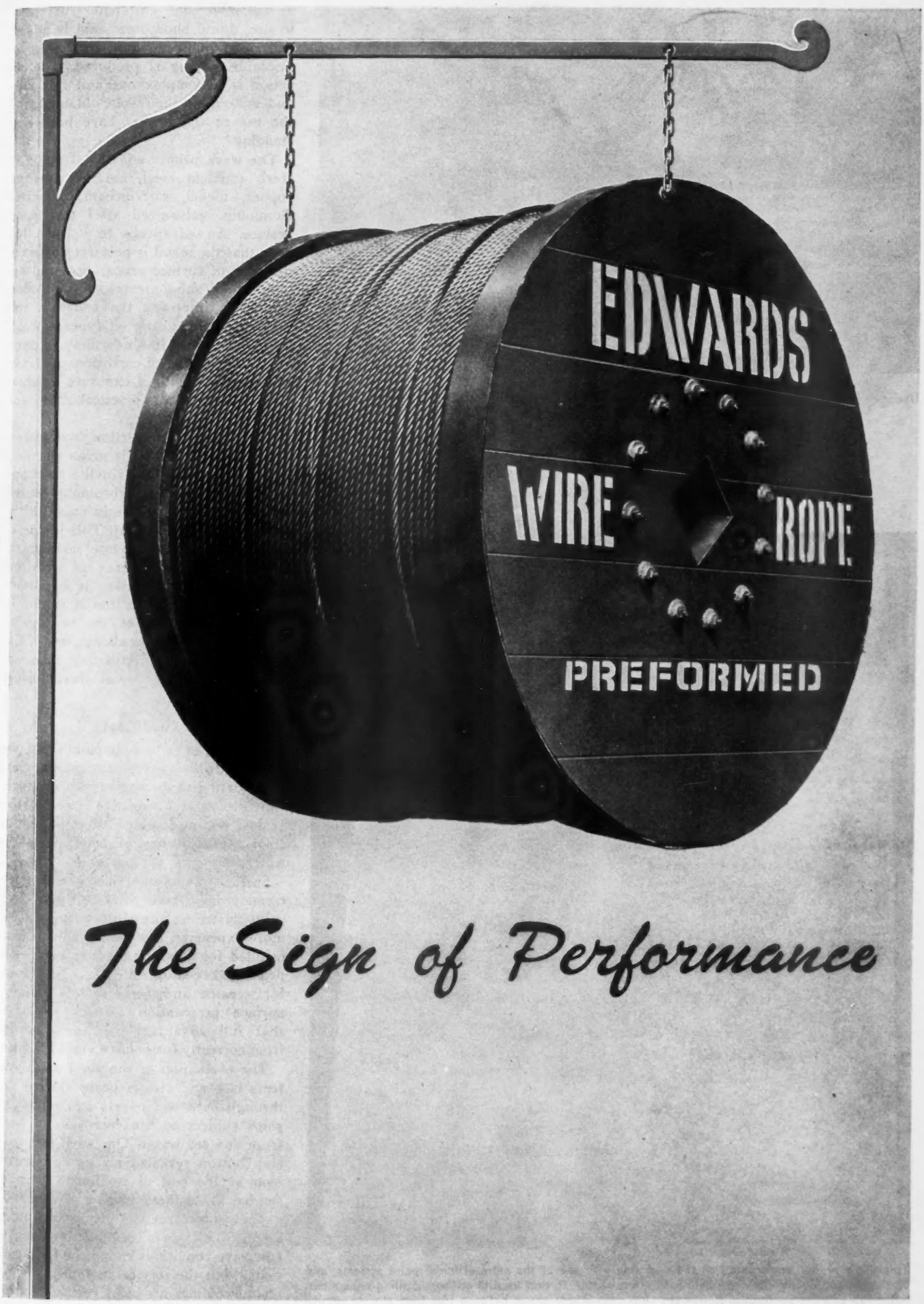
General Properties

In general, the properties of the vinyl chloride-acetate resins may be summarized as follows: They are completely lacking in odor, taste, and toxicity. They have extreme chemical inertness to such re-agents as acids, alkalies, alcohol, greases, oils, and petroleum thinners. They have high water resistance, both as to water vapor permeability and absorption. Most of them have excellent toughness and flexibility, and metal sheets coated with them can be drawn, spun, crimped, or otherwise fabricated, without loss of adhesion, and without marring or cracking the finish. Their resistance to weathering and aging is good.

The vinyl chloride-acetate resins are soluble in certain organic compounds, such as ketones, esters, chlorinated hydrocarbons, and nitroparaffins. The films are formed by the evaporation of these solvents, and since no oxidation or polymerization occurs, they are not subject to embrittlement or shrinkage on aging. The resins are water-white in color, and clean, white coatings, as well as tints are possible. With pigmentation, bright colors can also be prepared.

For use in the corrosive action of sea water, and, also, for use in the offshore drilling equipment, a painting system based on these vinyl chloride-acetate resins, coupled with one of the vinyl butyral resins, has been evolved. The system consists of a wash primer covered with anti-corrosive and anti-fouling coats.

In formulating the wash primer, the resin is dissolved and pigmented with



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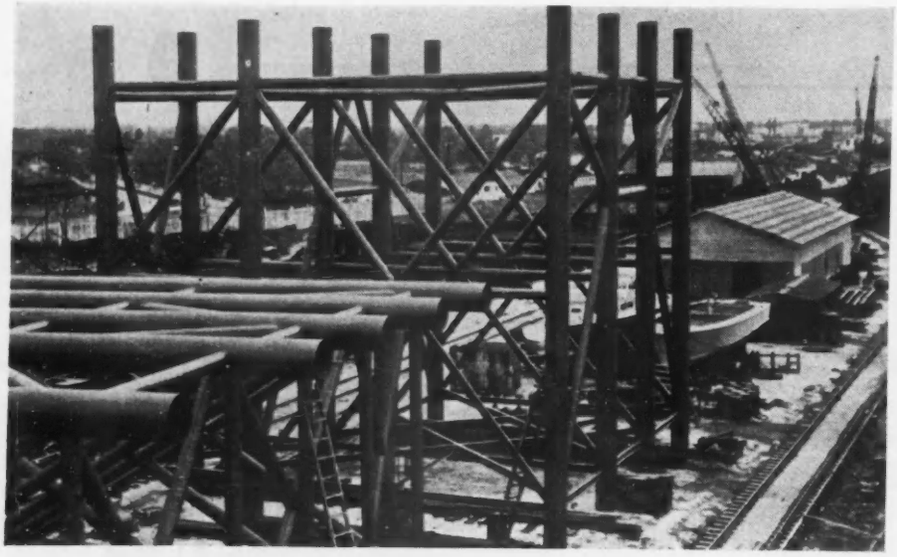

Undersea derrick structure in process of fabrication. These structures are subject to severe corrosion from the sea.

This ship's rudder was painted on the port side with one of the more efficient paint systems, and on the starboard side with the vinyl resin system similar to that used in offshore drilling equipment. After two years of continuous service the vinyl coated side shows virtually free from marine growth and corrosion, while the other side requires a complete refinishing treatment.

an insoluble zinc chromate. Just prior to use, dilute phosphoric acid is added, and, upon application and air drying, an insoluble coating is produced. The reaction is a complex one and not fully understood, but the results obtained with the use of the primer have been outstanding.

The wash primer adheres strongly to steel, stainless steel, zinc, cadmium, copper, nickel, chromium, anodized aluminum, galvanized steel and magnesium. An advantage to its use has been that the metal is protected between the time of surface preparation and application of subsequent coats and, also, in that it improves the adhesion and performance of nearly all types of coatings applied over it. Underfilm corrosion and the spreading of corrosion, generally prevalent at points of exposure by abrasion, are, for all practical purposes, eliminated.

For maximum protection from corrosion, the wash primer is given an intermediate coat based on vinylite resin and pigmented with zinc chromate or red lead. Adhesion of the resin finish to the wash primer is excellent. This is one of the vinyl chloride acetate copolymers modified by the presence of hydroxyl groups. This modification is important from another angle in that it results in wider compatibility of the resin with other vehicles, such as alkyds, ureas, and phenolic varnishes, imparting many of the valuable properties of vinyl finishes to these vehicles.

Final Coat

For both ship bottom paints and the offshore drilling equipment, a final vinyl resin coat, rich in copper content, provides long and effective protection against marine fouling. An aluminum or color top coat may be used above the water line.

Surface preparation has been an extremely important part of these vinyl paint systems. Sandblasting, though more expensive, has been highly recommended for producing better returns in prolonged coating life, less shutdown for repairs and replacements. Proper surface preparation assures the user that full advantage will be obtained from correctly formulated vinyl coatings.

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Mud Pump Selection

By H. L. WILLKE
Chief Engineer, Toledo Plant Division,
The National Supply Company

THE AUTHOR presents a method of determining mud flow pressures and the resulting mud pump loads. Mud pump requirements are analyzed for deep drilling. The advantages of multiple pump operations are stressed. Various types of drives are discussed and the features evaluated. This paper is substantially as presented before the Petroleum Mechanical Engineering Conference, Petroleum Division, ASME, Oklahoma City, in October.

AS THE development of larger drilling rigs proceeds and deeper drilling is encountered the slush pump is taking on a greater degree of importance. In the 1920's and early 1930's most all rigs were steam driven and it was not difficult to build a steam pump with sufficient capacity to meet the requirements of the times. This does not mean that developments and refinements were not necessary to obtain better service, but it does mean that capacity was not a principal problem.

The steam pump was a simple mechanical device with almost no limit in its capacity within the bounds of a portable unit. By the late 1930's, steam slush pumps of 900 horsepower capacity were available weighing approximately 23,000 pounds, which in oil field terms, could be easily moved. In addition to these factors, the nature of the steam pump allowed it to be used in multiples so that in reality the steam generating plant and other rig facilities were the only capacity limiting factors. Unfortunately, the very thing that gave steam pumps their unlimited mechanical capacity became their economic limitation. As competition in the oil industry became keener, the high cost of steam generation and water problems caused the use of steam rigs and pumps to become more and more prohibitive depending upon local conditions.

Internal combustion engine developments at that time, particularly, had advanced further in the direction of cheap power. It was then natural that most future developments came in so-called "power rigs." It is no secret now that the first power rigs were equipped with inadequate pump capacity, although it is doubtful whether this fact was fully recognized at the time. Rigs were being equipped with pumps that weighed and cost more than twice as much as steam pumps, but which had only about two-thirds of their capacity. Power pumps were further handicapped in that they could not be used in series. It was no longer possible to simply make the pump larger at reasonable increases in weight and cost as these factors were approaching economic and transportation limitations of that period.

Mud Flow Data

It became necessary for engineering staffs of operators and manufacturers to learn more about the functions of the pump related to drilling and properly to apply the capacity available. Research on the characteristics of mud flow was begun by Herrick,[1] 1932; Pigott,[2 and 3] 1933 and 1941; March and Gilbert,[4] 1935; and others. These developments came at about the same time as the advent of full hole tool joints, and clearly substantiated their use. Principal interest was to reduce pressures and increase drilling range. While it was realized greater circulation increased penetration rates, its full significance was not appreciated. These early works contributed greatly to the understanding of mud flow characteristics. It was demonstrated that drilling muds acted almost like a true fluid in turbulent flow, while in viscous flow it was greatly different. It became possible to calculate mud pressures when the viscosity-velocity relations and the density of the muds were known.

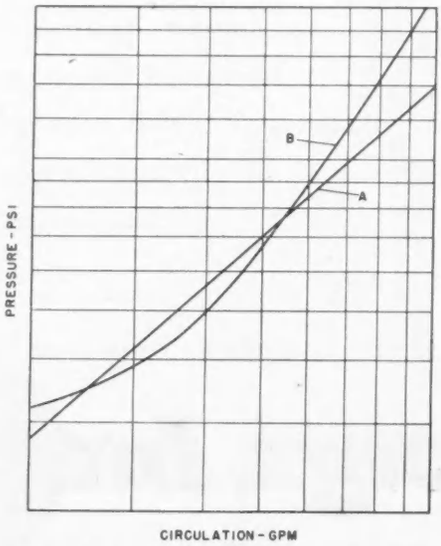
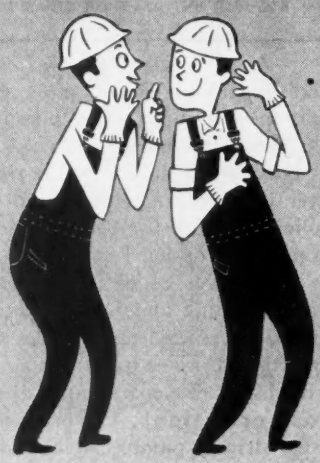


FIGURE 1. Sample of early field data vs. theoretical data.

Unfortunately, these analyses were considerably in advance of field practices, where at times not even the circulating rates were observed. For pump application a more practical and applicable method was necessary for general use where mud characteristics were not always known in advance.

Over this same period the writer's company accumulated flow data from rigs operating in all sections of the oil country. When this vast amount of data was compiled it appeared that the pressure varied directly in proportion to the circulation rate for any given hole and mud condition. While these empirical data checked quite accurately against field results they could not be reconciled with more theoretical methods. The field data reflected field practices and covered only a relatively small range of volumes. These volumes and circulation rates bridged the region between predominantly viscous and predominantly turbulent flows. Curve A, Figure 1, illustrates the straight line relationship of pressure and circulation as derived from field results. Curve B illustrates the theo-



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retical pressure relationship to circulation rate as the flow progresses from predominantly viscous to predominantly turbulent conditions. The flat portion of Curve B will vary because viscous flow pressures are greatly affected by the viscosity of the mud. It can be seen, however, that the empirical curve represented a reasonable average of the theoretical values.

As circulating rates were increased, it became evident that the original field data interpretation was in error in the large flow region. Additional data were collected and the curves replotted. The basic equation for these replotted curves is $P = (K + K_1 D)\ V^{1.6}$ From this equation it can be seen that, instead of varying directly as the volume, the pressure under higher rates varies as the 1.6 power of volume.

A sample of these curves presenting 4½-inch drill pipe with internal flush tool joint flow data is given in Figure 2. These curves lack accuracy in small flow rates where viscous flow exists in the drill pipe, but this has little bearing on the maximum loads encountered on a slush pump application. Also, these curves are only applicable to conventional bits, and with the advent of jet bits additional data will be required.

Recent contributions to the knowledge of mud flow characteristics have been made by Beck, Nuss and Dunn[5] and also by Nolley, Cannon and Ragland.[6] The former have developed a theoretical formula for computing slush pump pressures and the latter have compiled field test data including jet bit pressures and penetration rates.

Results from a number of these methods are presented in Figure 3. While all of these curves are for 4½-inch drill pipe, other conditions are not well enough fixed in published data to allow direct comparisons. It is interesting to note the general agreement in the slope of the curves and the fair correlation in pressure magnitudes even though well and pipe conditions are somewhat different.

Pigott and also Beck, Nuss and Dunn have done some work to determine the pressure drops in the annulus. With higher flow rates they have demonstrated that the annulus flows are often turbulent and as a result represent a fairly high percentage of the total pressure drop. This is important from the operators' standpoint because in some cases this adds enough to the bottom-hole pressure to cause loss of circulation. This is an indication that maximum annulus velocities may be reaching their optimum values, particularly in softer formations.

Even though annulus velocities may

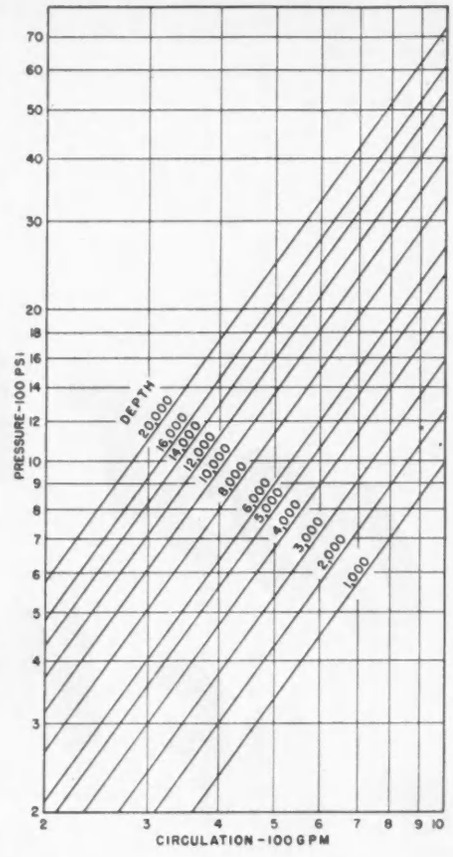

FIGURE 2. Pressure-volume-depth curves for 4½-inch internal flush drill pipe.

be reaching their ultimate, required pump capacities will not necessarily reach their ceiling. Jet bits in the present state of development have proven that penetration rates can be greatly increased except in harder formations for a given circulation rate. The added nozzle velocities obviously reflect an increase in the pump pressure and horsepower. It

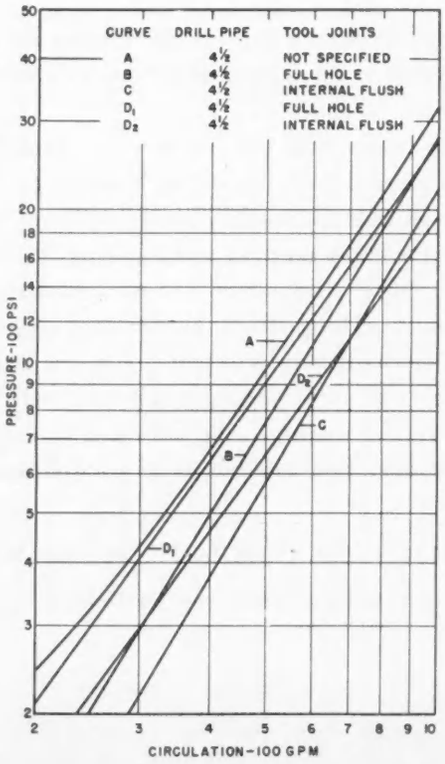

FIGURE 3. Pressure-volume curves for 4000 feet, according to several published investigations.

is reasonable to expect these developments to continue, and the pump to perform more and more work.

It must be admitted that the rig horsepower has too frequently been the determining factor for the selection of a pump size. For hard formation drilling the horsepower requirements for satisfactory hoisting and for circulating and rotating were near enough alike that rigs proportioned for adequate hoisting capacity had sufficient pump capacity. In softer formations, however, independently driven pumps have had to be added to take advantage of the higher penetration rates possible.

To make a proper pump selection the hole size and drill pipe size and type must be known for the most difficult holes contemplated for a rig. Figure 4 illustrates this problem in connection with a 20,000-foot well in which it is possible to set seven-inch outside diameter casing at 20,000 feet. The seven-inch outside diameter casing would not necessarily be set as an oil string, but would be held in reserve for an emergency. This requires that 9⅝-inch casing be carried as deep as possible. In this example it is assumed that the 9⅝-inch will be set at 15,000 feet, requiring a 12¼-inch hole to this depth.

Using flow-of-slush data for five-inch outside diameter drill pipe it is found that 1400 hyd hp pump capacity is required to maintain 3 fps annulus velocity in the 12¼-inch hole. Three fps has been expressed as a minimum desirable annulus velocity and even with jet bits maximum penetrating rates are obtained with higher velocities.[6]

Special attention to weight requirements and new and novel bearing applications have made possible the building of power slush pumps capable of performing the requirements of 20,000-foot drilling. These pumps are well within the transportation limitations of modern hauling equipment. At least two large power pumps of sufficient capacity are available. To obtain maximum drilling rates even these must be used in multiples. In Figure 4 it can be seen that under large volume low-pressure top-hole conditions parallel operation is required for 10,000 feet. Beyond this point the pumps can be operated either in parallel with very small liners or preferably in series with large liners.

Series operation of power pumps has now been proven mechanically practical; but its application is not yet widespread due to the lack of experience and the cost and availability of adequate air chambers essential to all but very low speed operation. These factors are not

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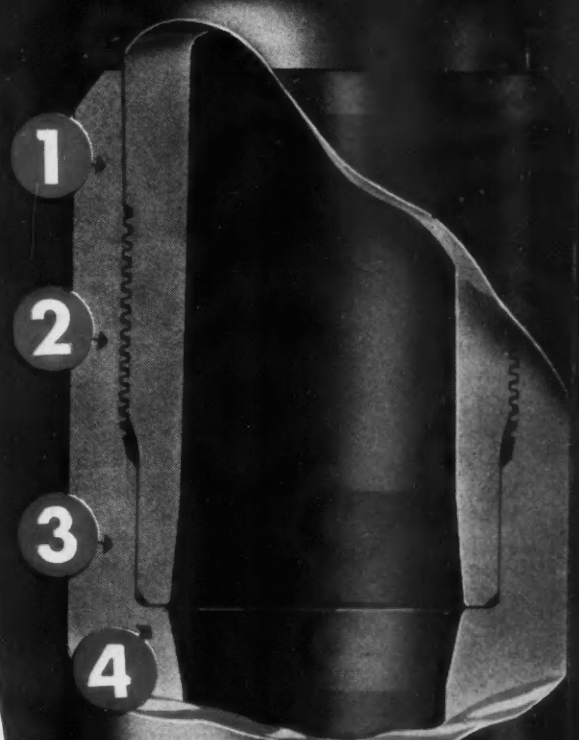

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prohibitive where large pump requirements are involved and it is expected that with further developments, series operation will become popular in medium pump requirements.

The principal advantages of multiple pump operation are, first, greater versatility in a two pump arrangement and, second, improved fluid end parts life.

In multiple pump operation the pumps are used in parallel under top-hole large-volume conditions and in series during the high pressure drilling of a well. This makes possible a considerable reduction in the number of liner and piston sizes, resulting in lower inventories than would be required for a single pump operation. Also, for a single pump to accomplish the same volumetric displacement, the fluid end would have to be of considerably larger proportions.

While in series each pump handles the full displacement, the low pressure pump takes fluid from the suction tank and discharges it into the suction of the high pressure pump, which in turn boosts the pressure to full manifold value. Thus, each pump is subjected to a differential pressure equal to only one-half of line pressure. It is obvious that the pump wearing parts of the low pressure pump are thus protected against the full severity of full line pressure. Similary, the high pressure pump is protected against the full severity of line pressure by its being subjected to a differential pressure only. It is easy to see that valve work under this condition is reduced as it is only sealing the differential pressure, and it is known that pistons and liners obtain like benefits. Also, large pistons normally used in series work are inherently better than extremely small pistons.

For most satisfactory multiple pump operation it is best to have a third pump of like size to be used in case of a shutdown of one of the two line pumps. However, it is not always possible to have an extra pump, and when one pump must be shut down it is interesting to note that series operation has an advantage over parallel operation. When one pump of a parallel operation is stopped,

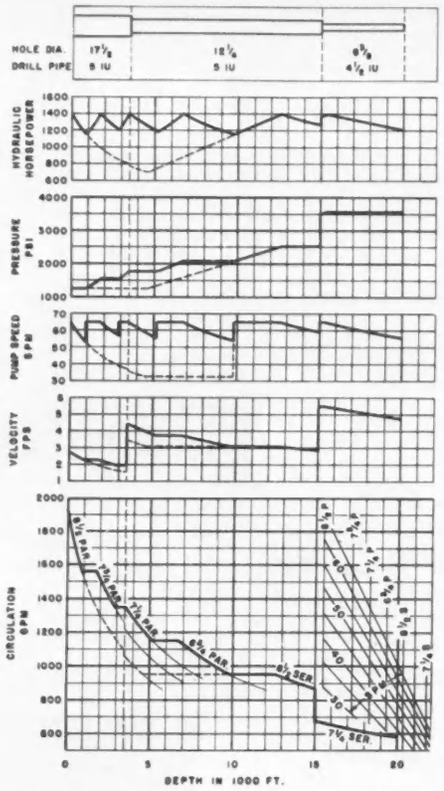

FIGURE 4. Mud pump performances vs. well depth.

the remaining pump will supply 50 percent as much displacement, 33 percent as much pressure, and the horsepower as a result will drop to 17 percent of that originally supplied.

In series, the remaining pump tends to continue full displacement and would do so if sufficient engine horsepower were available. With engines proportioned to the pump size, the pump speed will be reduced until the engine horsepower capacity balances that of the pump load. This point occurs when the displacement is equal to 65 percent, producing 50 percent pressure and as a result 33 percent horsepower. Examination of Table 1 will help clarify these two examples.

If sufficient horsepower is available, added work can be done up to the overload capacity of the pump. Thus, during an emergency period, with one pump shut down, the remaining pump of a series arrangement can deliver from two to four times as much horsepower as one of a pair of parallel pumps. These overload conditions are also tabulated in Table 1.

Another obvious advantage of series operation is the availability of accummulative pressures for emergencies.

Types of Drives

Along with the increase in pump capacity requirements, there has been also a growing need for better speed control for circulating or contributing functions. The conventional mechanical drive lends itself well and efficiently from rated speeds down to approximately 50 percent speed. Under some drilling conditions this reduction in speed does not reduce the circulation rate sufficiently to reduce the horsepower load to within the engine capacity. Under this condition the engines will stall and the only recourse is to reduce the liner sizes or in extreme emergencies to inactivate one of the pistons.

In many cases the drive ratio is purposely increased to lower the pump's maximum operating speed, throughout the entire drilling operation, to avoid excess circulation and pressure when it becomes necessary to use small drill pipe for the completion of a well. This is obviously a compromise.

Two-speed mechanical drives have been introduced to expand the mechanical drive speed range to both higher and lower values.

A low speed ratio presents the possibility of greatly overloading the pump. In cases of emergency this is often necessary and justifiable, but care should be taken not to operate under these conditions over extended periods of time. Under other conditions where smaller volumes are required than are possible with minimum pistons, a low speed ratio will actually avoid a pump and engine overload.

Hydraulic coupling applications on rig drives have mounted to a point where many big rigs are so equipped. It has been recognized that the hydraulic couplings have provided an ideal drive for the hoisting portion of the rig, giving these advantages: shock-absorption between the engine and transmission; isolation of the engine mass system so that torsional vibrations can be avoided or at least reduced to a minimum; and excellent speed control under full engine torque without the danger of stalling the engines.

Many of these advantages are carried over into the application of a hydraulic coupling on a pump drive. Aside from these equipment-saving features, the point uppermost in the user's mind is the ability to operate the pump at full pressure and low volume at, or near,

TABLE 1
Standby Characteristics of Multiple Pump Operation (7)

PUMP COMBINATION	Piston Diam.	Pump rpm	Volume Total	Volume 1 Pump	Pressure Total	Pressure 1 Pump	Hyd hp Total
1 Two in parallel	6¼	65	970	485	2,500	2,500	1,400
2 One of parallel	6¼	65	485	485	825	825	235
3 Line 2 in percent line 1	....	100	50	100	33	33	17
4 Two in series	8½	65	970	970	2,500	1,250	1,400
5 One of series	8½	42	630	630	1,250	1,250	460
6 Line 5 in percent line 4	....	65	65	65	50	100	33
7 One of series, 125 percent load	8½	48	720	720	1,560	1,560	670
8 Line 7 in percent line 4	....	74	74	74	63	125	48
9 One of series, 150 percent load	8½	54	810	810	1,875	1,875	890
10 Line 9 in percent line 4	....	83	83	83	75	150	64

Assumptions: Pressure varies as 1.6 power of ratio of volumes hp varies as 2.6 power of ratio of volumes.

stalling conditions. The operator can rest assured that the engine will not slow down beyond the speed at which maximum torque occurs.

Under the discussion of two-speed pump drives, this paper mentions that occasional high-pressure, low-volume overload conditions are probably necessary and justifiable during emergencies. These high pressures at near-stalling speeds also can be obtained by operating pumps in series, taking advantage of the favorable hydraulic coupling characteristics. Due to reduced inertias at these slow speeds, the couplings alone can compensate the fluctuating volume condition between pumps. These problems have been discussed in detail in a previous paper.[5]

Torque converters have come into rather prominent use, principally on small rigs. In driving pumps, torque converters facilitate a minimum number of piston diameter changes, making possible the drilling to moderate depths with only one piston size.

By properly proportioning the drive ratio, the pump can be operated at high speeds under top-hole large-volume conditions. The light gas-free mud commonly used at the top of the hole generally will allow speeds in excess of rating. The torque converter has substantially the same shock-absorbing characteristics as the hydraulic coupling and serves equally well as an equipment saver. The principal difference is that the torque converter provides a means of multiplying the torque to the pump input shaft. This provides for emergency high pressures with a corresponding pump overload. To obtain this added versatility a compromise is necessary in over-all efficiency, as the converter is less efficient than a straight mechanical

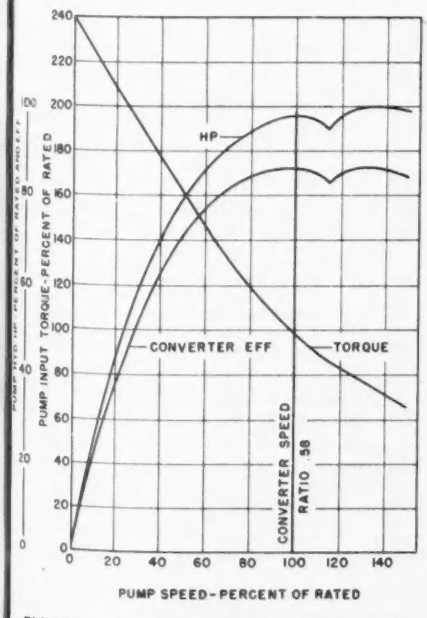

FIGURE 5. Performance characteristics of three-stage torque-converter pump drive.

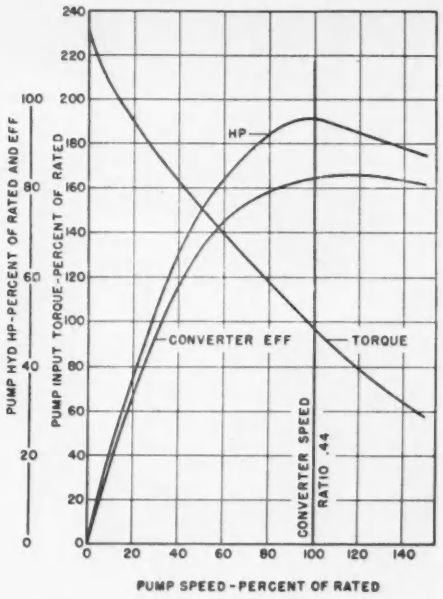

FIGURE 6. Performance characteristics of single-stage torque-converter pump drive.

drive or a hydraulic coupling in the usual operating range.

Since the application of a torque converter is somewhat complex, Figures 5 and 6 are included to demonstrate the principle of applying three-stage and single-stage converters to a pump.

In the case of the three-stage converter (Figure 5) the drive ratio is arranged so that the converter output shaft is operating at 44 percent of the input shaft speed when the engine and pump are running at rated speed and load. Thus the maximum horsepower delivery of the converter coincides with the rated pump speed under full load conditions. The maximum horsepower delivery point has been chosen rather than the maximum efficiency point for two reasons. First, the delivered horsepower to the pump at rated speed is slightly greater and, second, the torque multiplication to the pump input shaft is somewhat reduced.

This method of applying a converter to a pump results in the following: Maximum horsepower is delivered to the pump through its favorable operating speed range, overspeed is made possible with usable pressures, and the over-all torque-multiplication under stall conditions is brought more into line with the pump's mechanical strength for short-period high-pressure emergencies.

The single-stage converter (Figure 6) is applied substantially in the same manner, but it must be remembered that this converter is slightly more efficient, particularly for low speed reductions through the converter itself (high converter output shaft speeds). Applying the converter at a higher speed ratio appears attractive because of the higher efficiency, but to do so the pump overload would be further increased.

The versatility of the torque converter drive is better illustrated in Figure 7. In this figure pump performance for a single-stage torque-converter drive with a single liner size is superimposed on mechanical drive performance with four liner sizes. The mechanical drive may be with or without hydraulic couplings.

The pump performance is measured in displacement and pressure against well depth. It can be seen that the mechanical drive, when ample liner changes are made, will establish higher volumes and resulting higher pressures than the torque-converter drive because of the better over-all efficiency. It is noted, however, that the displacement curves for the mechanically driven pump show a greater decrease in volume than the curves for the converter-driven pump as the depth increases. When the pump is forced to slow down, as drilling progresses, the decrease in pump horsepower is less with the converter drive, even though the converter efficiency is reduced. Thus, a liner size can be used over a greater depth range.

For the user to derive the benefits of converter versatility, compromises must be made in the maximum horsepower delivered by the pump and the reduction of pump life if overloads are allowed, at reduced speeds, over an extended period. The user's requirements will largely determine whether the benefits out-weigh the compromises.

No illustration is provided for the three-stage converter as it is substantially the same as that for the single-stage.

Relations of Pump Load to Rating

This paper has discussed several drive applications which allow extreme over-

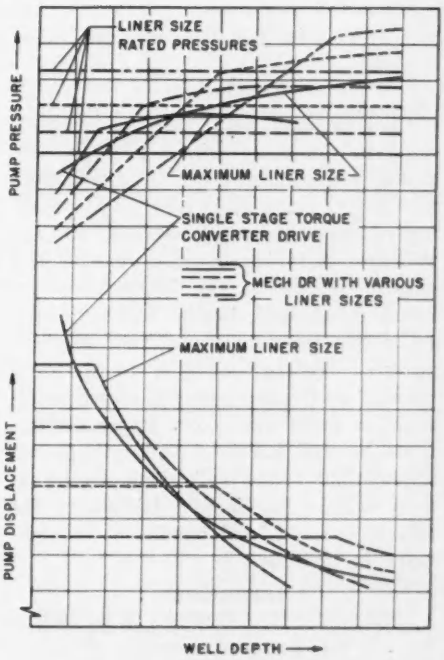

FIGURE 7. Comparison of converter and mechanical drive performance.

loading of the pump on a torque basis, even though the engines have been selected to match exactly the pump capacity at its rated speed.

A point which has not been discussed is the prevalent practice of supplying excess engine capacity to reduce engine maintenance. It is one of the purposes of this paper to point out the qualifications upon which these practices become sound engineering.

A soundly engineered power pump rating is largely based on durability, since such important elements as gears and bearings are rated on this accepted practice. The relative life-load relationship of these parts can be computed. The nominal rating may be selected on the basis of a high rating with short life or a low rating with long life.

Parts rated on a conservative durability basis will have an excessive strength measured in terms of yield or ultimate strengths. Other parts, when designed for satisfactorily low deflections, will have similar reserve yield and ultimate strengths. This makes possible the operation of power pumps at large overloads for a short period without any visible damage. However, it must be remembered that on a durability basis, life varies inversely with approximately the third power of load. For example, the bearing industry has determined that an increase of 100 percent load on a bearing will reduce its life to between one-tenth and one-eighth of the original value.

It is then obvious that to obtain reasonable life, pumps must be operated at or below their rating a large portion of their operating time. However, it appears to be good engineering to provide sufficient excess engine horsepower to obtain good engine performance and to meet any short duration emergency that is necessary for the successful drilling of a well.

Conclusions

Flow-of-slush data have been developed to the point where pump horsepower requirements can be anticipated and proper pump sizes selected to obtain maximum performance. Because the advantages of higher annulus velocity and greater jetting at the bit nozzles are being recognized, higher hydraulic circulating power is required. Higher-powered lighter-weight pumps, and parallel and series operations are available for these conditions. Pump designs must be well balanced and ratings and applications made with some conservatism to give satisfactory life under the widely varying load conditions encountered in drilling.

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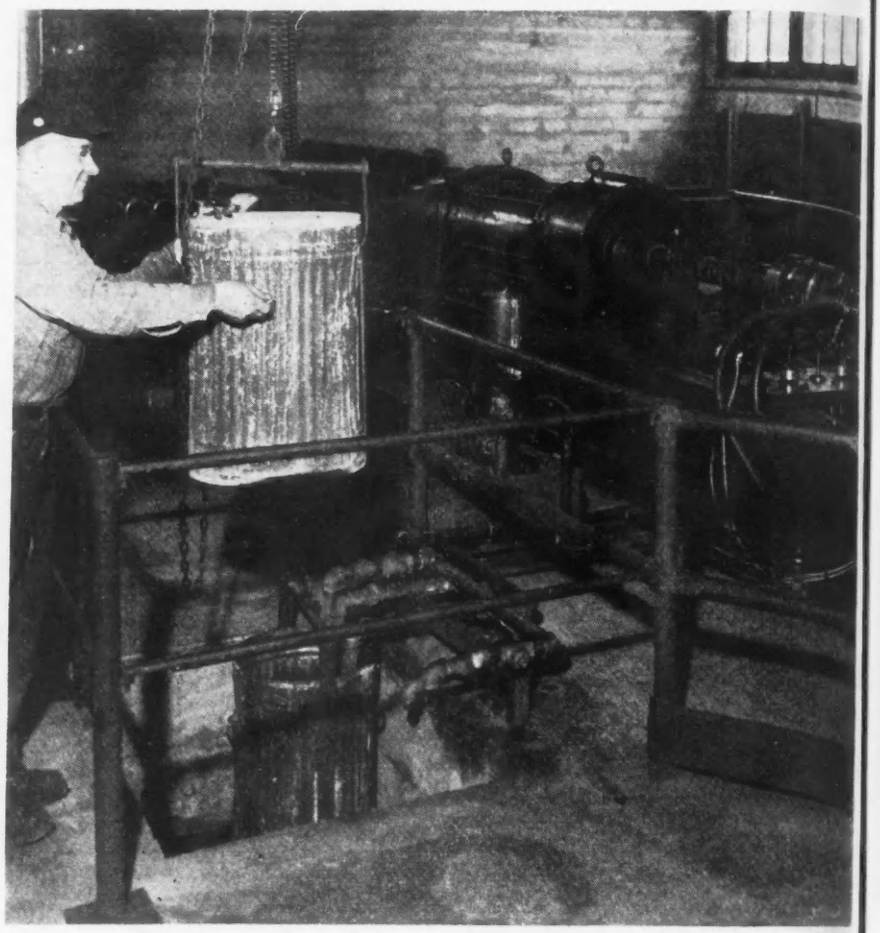

Corrosion Resistance of Pipe Measured

SINCE drill pipe frequently is used with a salt-base mud when penetrating zones charged with brine, and as the drill pipe is subject to bending stresses while operating in this medium, knowledge of the behavior of the steel under these conditions is important.

At the testing laboratory of the National Tube Company, sections of drill pipe are given a special test to determine the corrosion resistance of the material under simulated oilfield conditions. A section of the pipe is rigidly clamped in the face-place of a spinning machine which may be run at from one to 1000 revolutions per minute. The outer end of the pipe is held in a special fixture which allows a brine solution to be circulated into the section of pipe, while at the same time a heavy spring loading may be applied to the outer, or unsupported end of the pipe. Maximum loading is 1,200,000 inch pounds. Thus the specimen under test is subjected to a rotating and flexing test similar to that of a joint of pipe running in a crooked hole, or where the pipe is bowed by drilling conditions. The steel of the pipe is alternately compressed and stretched at each point in the circumference completes a cycle.

In the illustration a tank of corrosive brine is being lowered into the pit for circulation through the specimen under test.

Trends in Combating LOST CIRCULATION

By CARROLL V. SIDWELL
Head of Department of Petroleum Production, University of Tulsa

PROBLEMS OF lost circulation are inspected in the light of presently used materials for sealing off open formations, and the probable use of perlite and plastics as offering greater efficacy in obtaining the desired closure is discussed by the author in this article.

LOST circulation of drilling fluids and cement constitutes one of the major economic hazards in drilling operations. It is not possible to compute the cost to the industry, since no reliable records are available, but all agree that the cost has been tremendous. Furthermore, such costs continue to increase daily and the condition poses a serious threat in every drilling operation. Recently the Southwestern District Sub-Committee on Drilling Fluids, API, suggested that operators fill out a specially prepared study form for wells experiencing lost circulation troubles, probably the first industry-wide attempt to keep or maintain records covering this important problem.

Two wells alone that were drilled recently in different areas cost operators more than $400,000 in mud, lost circulation materials, cementing, and rig time in circulation difficulties before completing. One company involved has started a thorough investigation into reasons for losses of circulation and possible remedies.

The problem of lost circulation has been covered adequately in previous publications. Rogers,[1] in his book on drilling fluids, has set out the problem and also has covered the materials currently used to combat lost circulation. Louden[2] has discussed the present general practices in handling the problem. Cannon and Sullins[3] discussed the problem with reference to abnormal pressures on the Gulf Coast. Chaney[4] has stated that lost circulation is to be expected where abnormal pressures are drilled and further that reduction of pump pressures and viscosities offers the best solution. Both Cannon and Chaney seem to be in agreement that pulpy bulk agents are not the answer.

It is apparent that, as wells are drilled deeper and in areas such as the Rocky Mountains and the Gulf Coast, increased difficulties are to be expected.

Louden has stated that "in many operations the solution of the problem of lost circulation has depended upon hit-or-miss treatment and the application of materials chosen more from desperation than design." However, the problem should be possible of solution if the proper approach can be made. The logic of the approach would seem to fall into four categories:

1. Development of adequate records of case histories for study. The new API study form, if used generally and the data analyzed, should prove helpful.
2. Development of new materials capable of withstanding pressures and temperatures at greater depths.
3. Methods for field testing to evaluate different materials.
4. Correlation of geological studies on samples and cores to determine size and type of openings that need to be plugged should prove helpful.

With the above in mind the University of Tulsa started research studies more than four years ago on some of those problems which might be worked out in the laboratory, realizing that the final answer on anything tested in the laboratory must stand up under actual drilling conditions.

In discussing lost circulation, most writers discuss only drilling fluid problems. However, the loss of circulation of cement and the accompanying time and cost to get fill-ups and otherwise obtain satisfactory cement jobs might be more costly to the industry in some areas than mud losses if the figures were available. Many wells have cement losses into formations that involve no loss of fluid while drilling.

The problems that have been studied at the University of Tulsa are as follows:

1. Compressibility of lost circulation materials.
2. Bridging action of the new material perlite.
3. Viscosities of drilling fluids containing lost circulation materials.
4. Use of modified API filter press to evaluate lost circulation materials.
5. Tests on some light weight cements suitable for lost circulation and cementing casing.
6. Miscellaneous other uses for perlite in wells.

The application of the above findings to the problem will be discussed briefly.

Morris[5] found a wide variance in the compressibility of bulk agents commonly used for lost circulation. While he did not test all of the materials shown on Rogers' list, a sufficient number to be representative were tested.

Rogers classifies lost circulation materials into two types: (1) bulk formers, and (2) film formers. Louden classifies materials into plugging and bridging agents. He states: "Plugging agents differ from bridging agents because the latter denote a degree of rigidity which cannot be attributed to such common plugging agents as cotton bolls, beet pulp, bran, etc. When examined in their dry form these agents may exhibit a rigidity which does not remain when they have been wetted by the fluid phase."

To the list of materials by the above authors should be added two true bridging agents that are in field use: (1) ground plastics, and (2) perlite. These materials are inert solids that can be used to bridge openings that may be

later covered with mud film, or some of the common film-forming materials.

Since cost is a principal item of consideration in lost circulation, the application of Morris' data to cost of materials as shown in Figure 1 is important. By using his curves it is possible to calculate the cost per cubic foot of materials at the pressures at which they are used. For example, cottonseed hulls compress 60 percent at 5000 pounds per square inch, or 40 percent of the original bulk volumes remains at that pressure. Therefore, the cost per cubic foot at 5000 pounds should be 2.5 times the cost per cubic foot at the surface. Many of the materials are very expensive under this consideration.

Filling Void Space

Those familiar with lost circulation agree that void space must be filled, preferably away from the wall of the hole, at differential pressures between the well column pressure and the pressure in the formation.

Rogers states: "In sealing porous zones the seal should be made within the formation if possible. Such a seal gives the greatest strength and performance. Porous zones can be visualized as consisting of tortuous flow channels of varying size. If sealing agents of the proper size and type are used they will pass into the formation and flow until they contact openings smaller than themselves. Upon bridging over the open channel, flow is blocked or stopped entirely, depending upon the sealing properties of the agent. As this plastering of the smaller pores continues the fluid loss decreases. If the sealing materials are of such size that they are eventually able to plug all crevices around the hole, lost returns cease. The amount of sealing agents required to stop lost returns in any case depends upon the relative sizes of the pore openings and sealing agents.

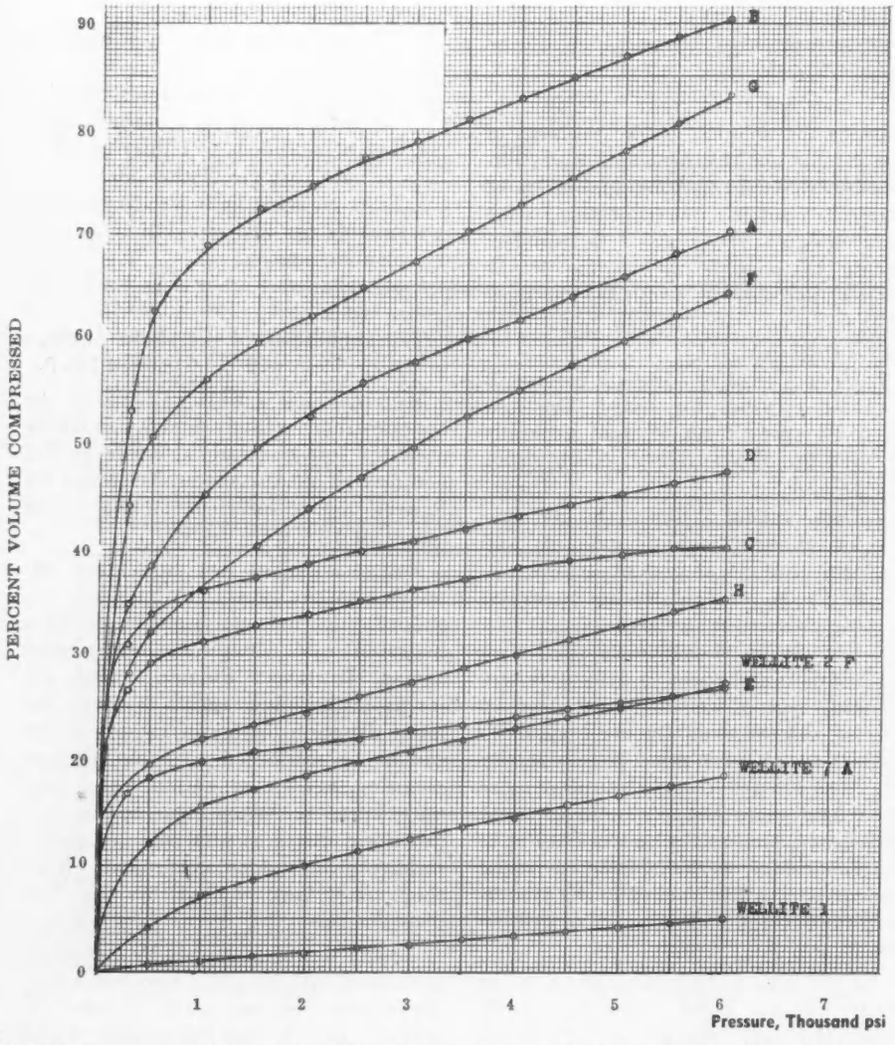

FIGURE 1. Compressibility of materials used to combat lost circulation. A. Shredded cellophane. B. Cellular plastic (styrene). C. Prairie hay. D. Redwood fibre. E. Feathers. F. Cottonseed hulls. G. Cut cellophane. H. Pumice.

"The first step in handling lost returns, in the absence of knowledge to the contrary, is to assume that the pore openings are relatively small and make additions to the mud accordingly. Additions of the film type sealing agents in the order of three pounds per barrel are made first. If this is insufficient, the quantity should be gradually increased up to 12 to 15 pounds per barrel. If the loss continues high and cavernous formations are suspected, roughage-type materials such as cottonseed hulls should be used along with the sealers. A total of about 30 pounds per barrel is the maximum quantity of sealing agents of all types used at one time."

The cost to fill or bridge, and the rapidity with which it can be accomplished has an important bearing on cost of materials including mud, and also on day work expense.

Bridging Experiments

Barberii[6] experimented with a circulating system using perlite as a bridging agent. He found that satisfactory bridging could be accomplished with perlite in a fluid medium. His work supports the work of Coberly[7] on bridging effect of sand grains where it was found experimentally that round grains would bridge on rectangular openings where the grain diameter was half the width of the opening and on circular openings where the grain was one-third the diameter opening.

Field testing, discussed by Barberii, where selected perlite has been used in wells by the Wellite Corporation of Tulsa indicated that the pumpability, angularity of the material, grading of sizes to secure maximum densities and selection of proper perlites probably increase the bridging effect that would be expected under the Coberly principle. Many perlites are known but only a few tested have been found usable for well work.

The bridging effect or plugging ability of inert solids was discussed by Townsend[8] and Stormont[14] with reference to use of a mixture of ground plastic and other inert materials. Townsend states:

"In most of the applications for temporary plugging materials other than during the actual drilling of a well, it has been found that the particle size of the filler materials and their specific gravities with respect to their carrying media are rather critical. For such applications, laboratory tests and field experience have shown that solid particles of graded sizes may be used for the regaining of lost circulation. This can be projected to the extent that the particles should possess certain structural shape, such as angular or spherical. And, in

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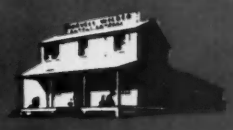

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most applications, it is desirable to introduce these materials into a well in a definite ratio of particle sizes and amounts of the material to the particular carrying medium, depending upon the formation conditions involved."

Perlite Properties

Perlites selected for well use have been found to be effective in lost circulation, probably because of good pumpability characteristics, inertness, resistance to distortion, and angularity. They have proven particularly effective in fractured and creviced formations in deep wells. They may be used satisfactorily in any drilling fluid. Some of the difficulty encountered in wells probably is due to using film-forming agents as bridging agents without much chance for success since the pulpy materials have high compressibility and will not resist distortion when placed in formation openings. Rogers gives the bursting strength of cellophane strips as 30 pounds per square inch. Where these materials are placed on the wall of the hole it would take a very thick film to withstand the differential pressures usually encountered between the fluid column pressures and those in the trouble zones. However, if these film-forming or plastering agents could be backed up, away from the wall of the hole, with proper bridging agents their strength would be materially increased. This is also true of the other pulpy sealing agents.

Mica is not considered here as a true bridging agent of the inert solid type because the particles lack somewhere near equal three dimension size. A bridging agent to be used on the Coberly principle should preferably have three nearly equal dimensions of particle size.

The proper selection and use of bridging materials offers the possibility of partial elimination of cementing of lost circulation with its accompanying cost of rig time and mud contamination. Experience with bridging agents in a well near Mexia, Texas, solved the problem where numerous cement plugs had been unsuccessfully tried. Bridging agents carried in the drilling fluid might partially solve the plugging of openings where formations on the Gulf Coast or other areas break down under high pressures approaching overburden pressures shown by Cannon, Louden, and Chaney.

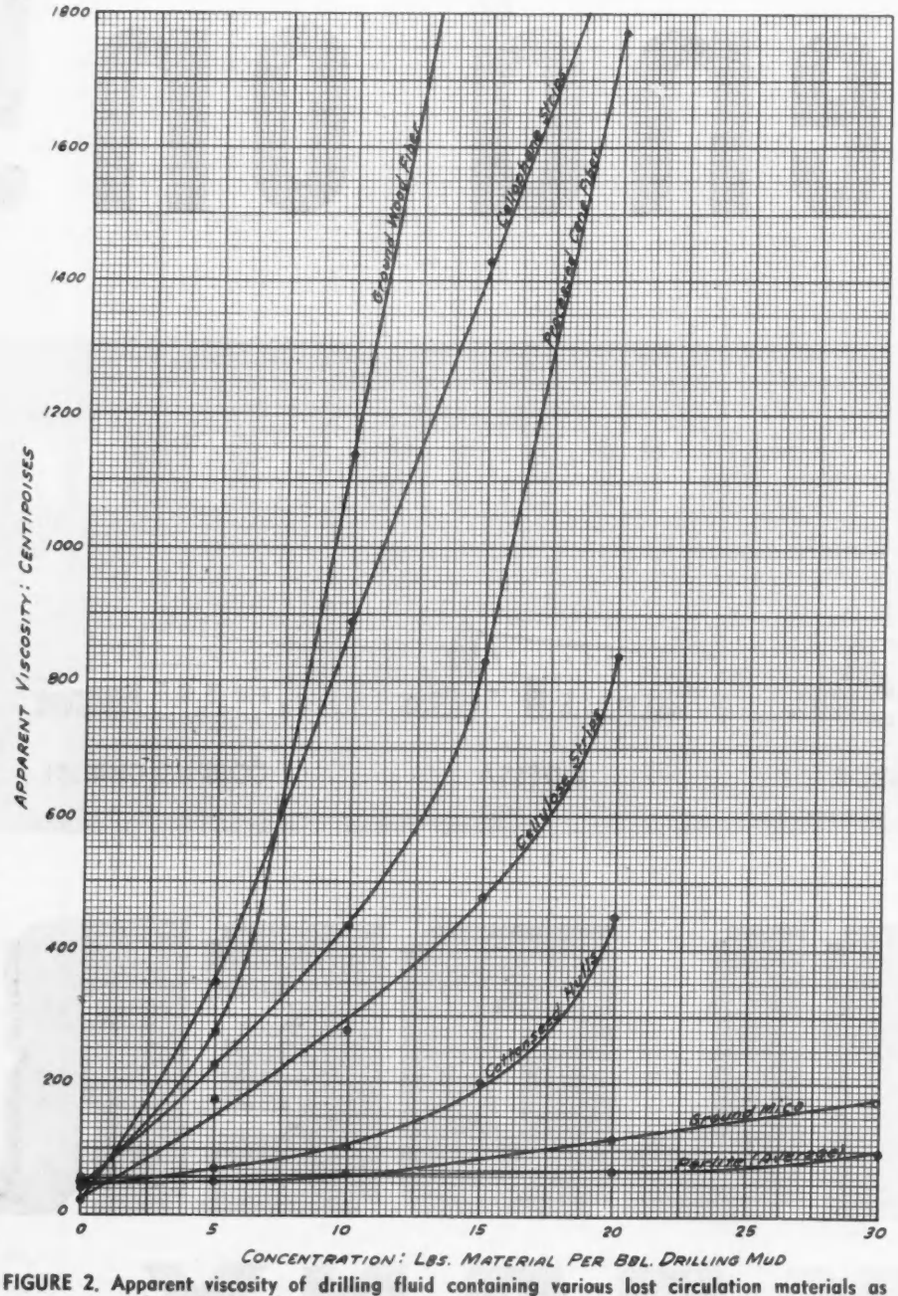

FIGURE 2. Apparent viscosity of drilling fluid containing various lost circulation materials as determined by Stormer propeller rotor at 600 revolutions per minute.

Effect of Materials on Viscosities

A summary of the research of Pringle[9] on viscosities to be expected in drilling fluids with added lost circulation materials in various concentrations is shown on Figure 2. These curves explain the inability to add, as Rogers stated, concentrations above 20 to 30 pounds per barrel of most sealing agents. He further states that the rate of loss will be directly proportional to the increase in viscosity, and that the top desirable viscosity is 75 centipoises and top Stormer gel strength is about 60 grams.

From the above it is obvious that high viscosities obtained with pulpy or fibrous sealing agents increase pump pressures and hence differential pressures across the offending formation.

The lack of pumpability of most sealing agents above 30 pounds per barrel limits the amount that can be placed with each barrel of drilling fluid. Regardless of the amount of void space to be filled, whether they be crevices, cracks, fissures, vugs, or caverns, the lost circulation materials must fill up or bridge these openings before satisfactory results are obtained. The fact that the softer materials are also highly compressible means that additional mud must be used to carry the bulk volume needed to fill up the openings away from the hole. Where high priced muds are used the cost can become almost prohibitive.

Perlite has been pumped in wells in concentrations of 75 pounds per barrel. Under some conditions this concentration could probably be increased. Since this material is much less compressible than any other material except mica and ground plastic, the amount of drilling fluid necessary to lose in filling the void space is materially decreased. In one instance it has been pumped in water. However, this is not to be recommended

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unless as a last resort in an event time to mix mud is not available.

Laboratory Testing

Corbitt[10] has investigated the use of API modified filter press for evaluation of lost circulation materials. He has come to the conclusion that the recommended apparatus, with some additional modifications, may be used to determine plugging ability.

However, the results of this work would indicate that a simple laboratory circulating system would probably give better results. This is supported by the methods now used by several companies in evaluating materials where pumping is considered most desirable. Barberii's work indicates that a modification of his apparatus would possibly serve to give results on evaluation.

White[11] has shown that suitable cements for cementing casing can be made with selected perlite. These cements are light weight and have less permeability than standard cements. Cannon[12] has shown that high water ratio cements are adequate for oil well use. The addition of perlite to these will improve their setting characteristics.

In addition to lightening the slurry weight to 10.5 pounds with equal volumes of perlite to cement, the perlite also serves as a bridging agent in the cement body. The weight secured is much less than that of low-water loss cements.

Oil well cement slurry is a plastic fluid which contains solid particles usually suspended in a water medium. Since it has been found possible to bridge off against the loss of mud in wells using perlite, the same principle can be applied to decrease cement losses and increase fill-up behind casing. Perlite added to low water-loss cements, suggested by Howard and Clark,[13] will improve their pumpability and blocking characteristics and decrease their weight. Some areas, notably West Texas and the Texas Panhandle, are unable to get required satisfactory fillups. In some instances this requires perforating, squeezing, and additional loss of rig time. Satisfactory bridging with solids in the mud ahead of the cement and also in the cement itself is considered feasible in helping to overcome loss of circulation of cement. Lightening slurries reduces the pump pressures required and the corresponding tendency toward loss of cement into formation openings at the higher pressures.

Perlite of proper sizes in bentonite gels having high viscosity and high angle of repose will improve the sealing ability of these gels in zones of lost circulation. The material added to high gel, low water-loss cements will increase their effectiveness in cementing lost circulation zones.

Additional investigations are in progress which may prove helpful in further solution of the problem of lost circulation.

In conclusion the following might be pointed out:

1. Bridging materials of perlite and ground plastic are now being used satisfactorily in further solution of the lost circulation problem. Perlite, while particularly effective in high gel strength bentonite mud, can also be used with a high expectancy of good results in any drilling fluid.

2. Properly selected perlite can be pumped in higher concentrations than other materials and requires less loss of mud to place a fixed volume of plugging material.

3. Compressibility of materials affects their cost at pressures used.

4. High Stormer viscosities account for lack of pumpability of pulpy materials.

5. Suitable light weight cements with densities less than presently used and without permeability can possibly be used against loss of mud and cement in wells.

6. Concerted effort to use API study form would make possible further progress in solution of problem.

7. Cost figures on lost circulation of fluids and cements from individual companies would emphasize the necessity of further research. Part of this research could be carried on in the universities.

8. Personnel of the drilling industry should be trained on the necessity of recording information as conditions develop.

9. Further cooperation with the geologist to determine the nature and size of openings to be expected would also prove helpful.

About the Author

CARROLL V. SIDWELL was graduated from Oklahoma University in 1923 with a B.S. degree in geology. In 1924 he was granted a fellowship from that University for graduate work. He spent one year in Tampico, Mexico, as a subsurface geologist with Cortez Oil Corporation. For seven years he was associated with Amerada Petroleum Corporation as a division production engineer in Oklahoma and Kansas. From 1939-41 he was consulting engineer on contract with the Oklahoma City Wilcox Secondary Recovery Association. His work in connection with this position was research into the possibilities of the application of the secondary recovery method in the Oklahoma City Wilcox zone. During World War II he went into private practice as a consulting engineer. At the present time he is Head of the Department of Petroleum Production Engineering of Tulsa University, consulting engineer for The Corps of Engineers, U. S. A., the Department of Defense, and a number of gas and oil companies.

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To cope with this situation a boiler stack was hinged to the outside shell of the boiler. When the rig is moved, the boiler stack is unflanged from the shell and the stack cradled on top of the boiler. It is secured in this position until set up at the next location where it can easily be erected and bolted back in place. Little handling is required in moving, thereby bringing about much saving in stack repairs as well as saving time in erecting this equipment.

Two matching flange faces are made. One flange is welded to the base of the stack and the second to the flue opening in the boiler shell. The stack is secured to the boiler by four bolts. Two hinge plates are welded in a vertical position to the boiler shell as shown. These plates are triangular and have holes bored at the apex of the plate. Two corresponding pieces are welded to the boiler stack so that they terminate at the fixed hinge welded to the boiler. Bolts hinge the two plates together.

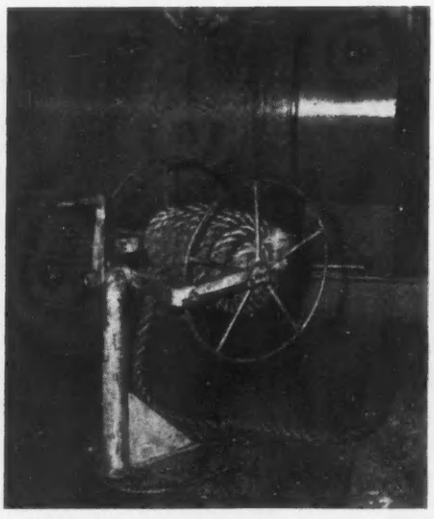
A cradle for the stack is mounted on top of the boiler shell behind the stack so that when the latter is unflanged and laid horizontally, the cradle will support it off the boiler. This cradle is made with "ears" that match a piece of strap iron which is bolted over the stack to the cradle in order to secure the stack in this position.

HOW TO—Make Braking Spool To Store Catline

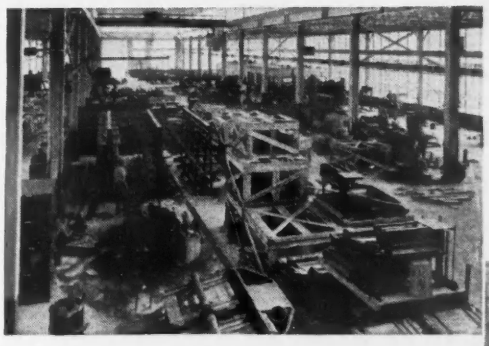
Instead of permitting surplus catline to lie on the derrick floor near the cathead to form a stumbling hazard, one contractor made this convenient catline spool on which the line is stored. When the line is not in use, it can be coiled on this spool so that only a minimum of line is resting on the floor.

The spool is unusual in that it is equipped with a locking device which makes it possible to brake the spool and prevent the line from unreeling. Another feature is a rotating handle which permits the spool to be rotated through 90 degrees or in an upright position.

The spooling device is supported by a 28-inch piece of three-inch pipe mounted and braced on a piece of plate steel as shown. A bracket of one-half-inch strap steel serves to support the spool axles, which are equipped at each end with 24-inch diameter wheels made of sucker rod material. The axle extends through the bracket at one end so the braking device could be added. It is merely a ring that fits rather snugly over the axle and equipped with a bearing joint into which the end of a bolt rests. This bolt threads through a nut welded to the bracket so that when the bolt progresses through the nut, pressure is caused to bear on the axle by the close fitting ring. In this manner, the spool is prevented from turning.



The bracket is mounted on the upright by a bolt which passes through a horizontal nipple welded to the three-inch support. A crank is attached to this bolt and the nut drawn up tightly. By turning the crank, the spool can be positioned at any angle desired.



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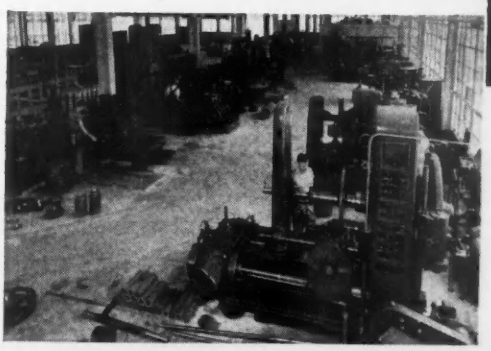

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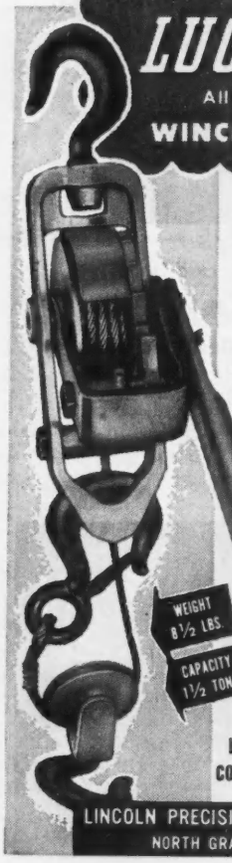

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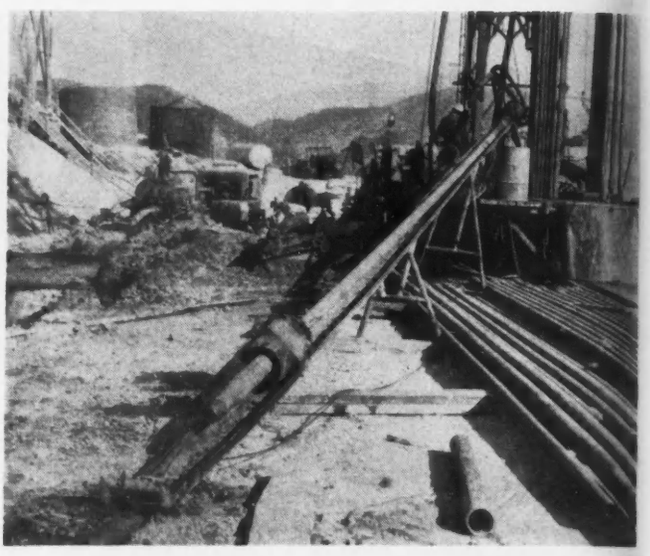
DRILLING HINTS

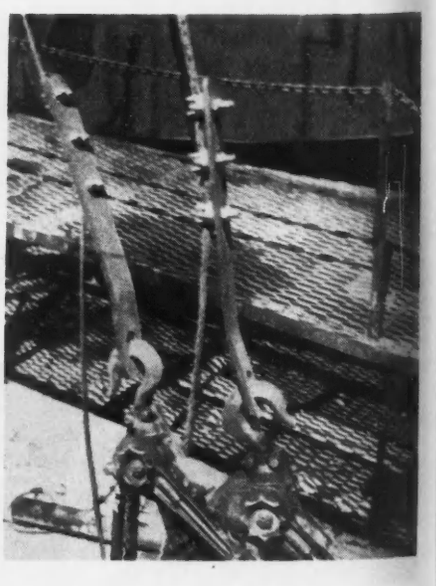
HOW TO—Eliminate Small Rig Rathole



The practice of lowering the kelly and kelly bushing onto a long, sloping trough instead of in a rathole is becoming increasingly popular among drilling contractors operating light rigs in shallow drilling territory. In the installation shown, the trough is made of casing split in half lengthwise and supported at several points by A-frame type legs. The latter segments are made of salvage tubing materials. The upper end of the unit is positioned on the edge of the rig floor, preferably at one corner so that the chute will take up a minimum of otherwise usable yard space. The kelly is pulled out on the support by means of a light line run through a small pulley at the outer end of the chute.

The entire assembly is light, easily broken down for transportation between jobs, and because it eliminates the need for drilling a rathole, reduces the overall cost of drilling a well. It is one way of reducing settingup costs on a short drilling job, where the time spent in setting up represents a sizable proportion of the entire time spent on the well.

HOW TO—Attach Guy Lines to Deadman



A different method of attaching derrick guy lines to the dead man anchor has been developed which does not require a bailer hitch to be made at the ground end nor any other kind of bend at the chain tightener of a turnbuckle. A strap of flat iron one-half-inch by four inches wide and as long as desired is prepared by cutting a hole in one end large enough so that the chain tightener hook or the hook of a turnbuckle can be inserted easily.

Holes are drilled along the strap near the opposite end to match the conventional U-bolts of a common wire line clamp, using as many wire line clamps as necessary to hold the line without danger of slipping through the clamps. Excess wire line used for the derrick guy lines is coiled on the ground near the anchor so that the same lines can be used at successive locations.

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HOW TO—Anchor and Support Rathole

Since the rathole casing supports the weight of both the kelly and swivel, some means must be provided to carry this load. This unique device was fabricated in the welding shop from scrap pieces of ten-inch casing to accommodate 8⅝-inch rathole casing. The top edge of this casing supported the kelly bushing upon which rested the entire weight of the swivel and kelly.

The area below the derrick floor was completely floored over with heavy timber, and a few heavy planks were placed at 90 degrees to the flooring to provide additional foundation for the rathole casing. The outer piece, made from ten-inch casing, had been split in half and hinged on one side. It was welded at the desired angle to a bottom plate of heavy plate steel which was also split to permit a hinged action of the complete unit.

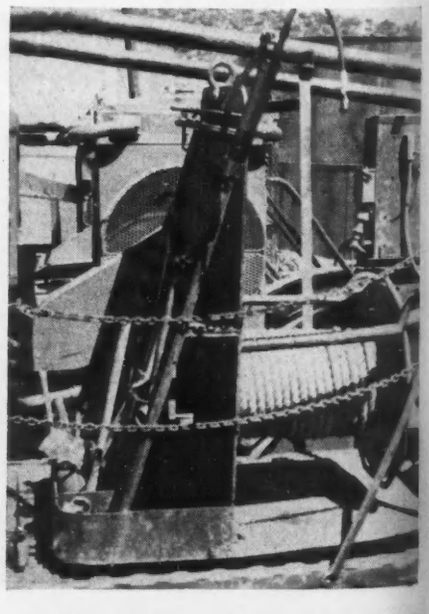
This larger casing section was locked in the closed position by a curved piece of plate material that had welded lugs on either end. These lugs fitted into slots made by adding smaller pieces of plate steel as shown. The hinged idea was incorporated in order that the anchor device could be installed after the ground had been floored over and after the rathole had been drilled.

The rathole casing was equipped with wing lugs welded to opposite sides at a point so that the top of the rathole casing would support both swivel and kelly at the proper height above the derrick floor. The unit adequately serves as a foundation for the casing and is simple to install and remove.

HOW TO—Rack Tools and Manila Cable

A combination tool board and mounting for a manila cable spool has been constructed which occupies a small amount of space on the floor of a shallow-hole portable drilling rig. The base is made of a rectangular sheet of tank steel to which the tool board and spool supports are welded. The board for racking small tools and grease guns is set on an incline with the space around the base of the board enclosed with a flat strip of metal to serve as a receptacle for parts and tools which cannot be hung on hooks attached to the tool board.

A vertical sheet of steel is welded behind the tool board to support the top of the board and to serve as one of the bearing supports for the cable spool. The cable spool is a steel drum with end pieces and fitted with a crank for spooling loose cable and to control unwinding when fresh cable is required. An eye bolt welded to the top of the tool board where it is attached to the vertical sheet of steel serves as a means of attaching a sling when loading or unloading from a truck.

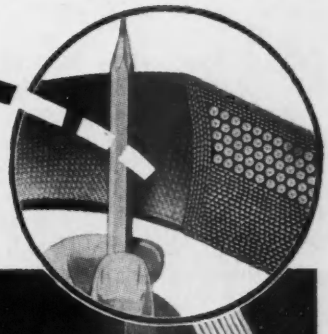


You can actually *feel* the sides of a belt *change shape* as the belt bends.

In Two Minutes You Can See Exactly How . . .

The Concave Side

(U.S. Patent No. 1813698)



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Take *any* V-belt in your hands and bend it as it bends in going around a pulley. You will see that the top of the belt, being under *tension*, grows *narrower*. The body, under compression, *widens*. The sides *bulge out*.

This shape change—in a *straight-sided* V-belt—is shown in Figures 1 and 1-A, below.

Straight-Sided V-Belt

How Straight-Sided V-Belt Bulges in Sheave-Groove.

Now look at Figures 2 and 2-A. There you see how the *same shape change* affects the V-belt built with the precisely engineered *Concave Side* (U.S. Patent No. 1813698).

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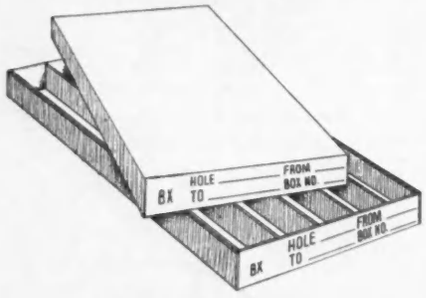

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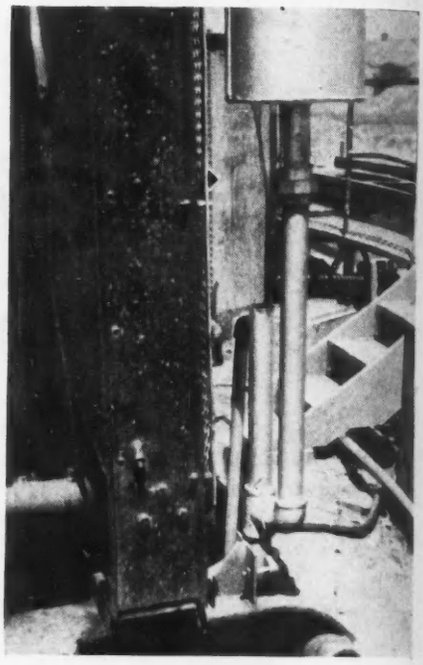
HOW TO—Seal Muffler with Water Leg

When quench water is injected into the exhaust of drilling engines to suppress the hazard of backfires or sparks, force of the gases and the heat carried with them does not always dissipate this excess moisture. When mufflers are installed in a vertical position this free water drops to the bottom of the muffler and collects there to reduce the efficiency of the muffler and eventually fill it up.

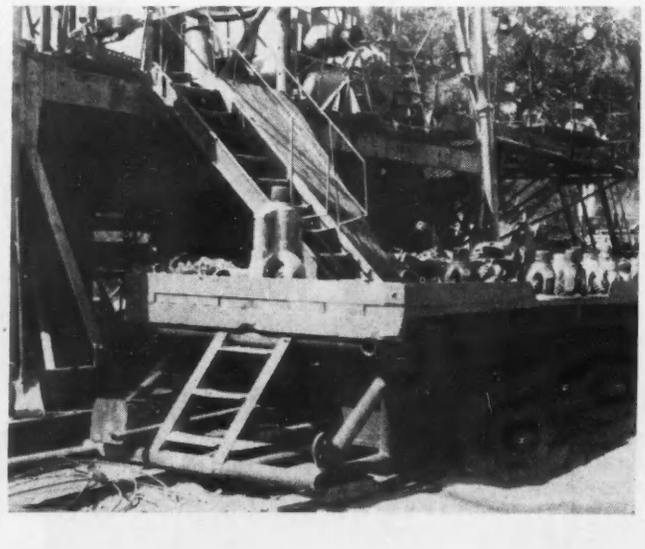
To provide an outlet for this water and at the same time to make a seal which will not allow flames or hot gases to escape this outlet, a return bend was added to the drip connection as shown. Not only does it serve as a drain for this water, but it acts as a support for the muffler as well.

A two-inch collar welded to the center of the bottom plate on the muffler case contains a nipple with a companion flange or part of a lip union to which the leg of the water seal is attached. An ell and a short nipple on the bottom of the leg is used to connect the vertical leg of the seal and the piece of pipe which rests on the engine sub-structure to support the muffler and fittings. The vertical seal pipe is open at the top and has an overflow connection barely visible behind this open ended water leg. Instead



of permitting water to flow over the ground around the engines, this drain water is carried off by the overflow connection. This addition to the muffler system is simple to install and once connected remains on the engine as an integral part of the power unit.

HOW TO—Build Versatile Loading Deck



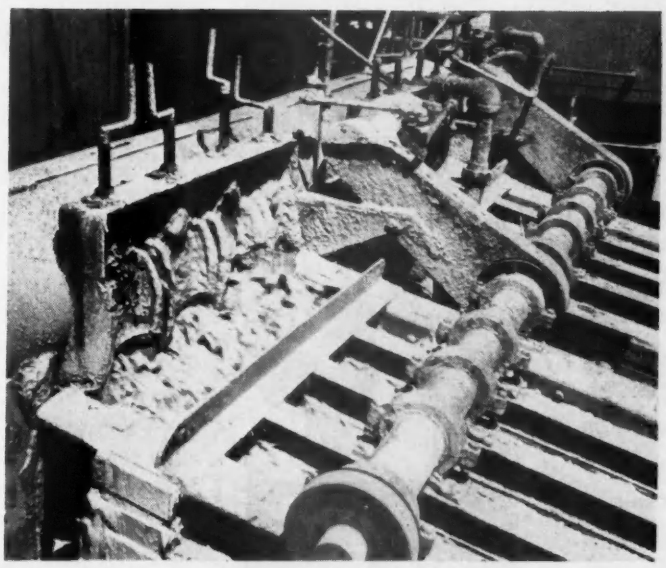
Rigging-up and tearing down are the two operations that offer the chief possibilities of effecting substantial savings in operating costs. To simplify and reduce costs of moving between wells, one contractor employs a multi-purpose, combination loading deck and tool rack which serves as (1) loading platform of truck bed height from which tools and supplies can be taken on up to the derrick floor with the cat

line; (2) a deck on which bits, reamers, subs and miscellaneous tools may be stored temporarily until needed; (3) a unit in which sheet steel bins are mounted in readily accessible position between deck and bottom runners; and (4) a long rack in which miscellaneous piping, lumber or long tools may be transported and stored. Built of salvaged drill pipe and tubing materials, the skid-base unit shown in the photograph is decked over with three-inch planking and is edged with a low retaining wall of rig angle iron.

Built to conform to the legal eight-foot width limitation, the unit is compact for easy hauling, and is equipped with lifting eyes at each corner, as well as tie-down rings attached to the skid runners on each side. It provides a space for the carrying and storing of the hundreds of miscellaneous small fittings, valves, bits, soft rope, chain, etc., that are needed at some time or another at every location. It is compactly built to withstand the rough service usually accorded a unit of this kind, and is a piece of equipment that can be the first to be set up beside the derrick, and the last to be removed, enabling the crew to have the storage facilities at hand during the rig-building and tearing-out operations.

HOW TO—Direct Flow of Mud on Screen

An even distribution of mud across the shale shaker screen can be insured by controlling the flow from the mud return line. By causing the mud to flow evenly over the screen, greater efficiency is derived from the shale shakers since a more effective screen area is used than in the case where a greater volume of mud flows across the middle of the screens.



The device illustrated is one method by which this even distribution was accomplished. The mud return line was made of salvaged 24-inch casing which had been unitized on the same skid with two parallel shale shakers as shown. The receiving end of the shakers butted up against the mud return line so that mud could flow from a box-like opening cut into the side of the mud return line.

Instead of leaving an unobstructed opening spanning the width of the screens, four gates were incorporated in a framework welded to the mud return line. These gates, made of sheet steel, slide up and down in guides which hold them in position. The amount of opening in each gate is adjusted by a screw handle shown extending from the horizontal edge of the abutting framework. A matching nut was welded to this supporting frame to permit raising and lowering of the gate by screwing or unscrewing the handle.

The framework which holds the gates in place was welded directly to the 24-inch casing and acted as a lip over which the mud passed onto the screens. The middle gate can be closed down slightly more than the edge gates so that an even distribution of mud over the screen can be obtained. When one shaker is inoperative, all gates can easily be closed tightly to shut off entirely the flow of mud.

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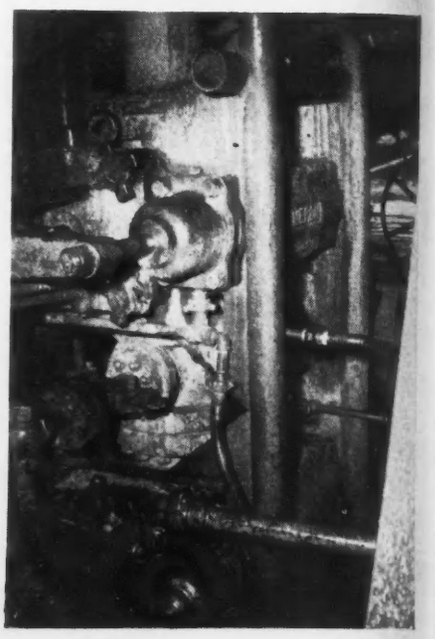
HOW TO—Simplify Transport of Blowout Preventer Assembly

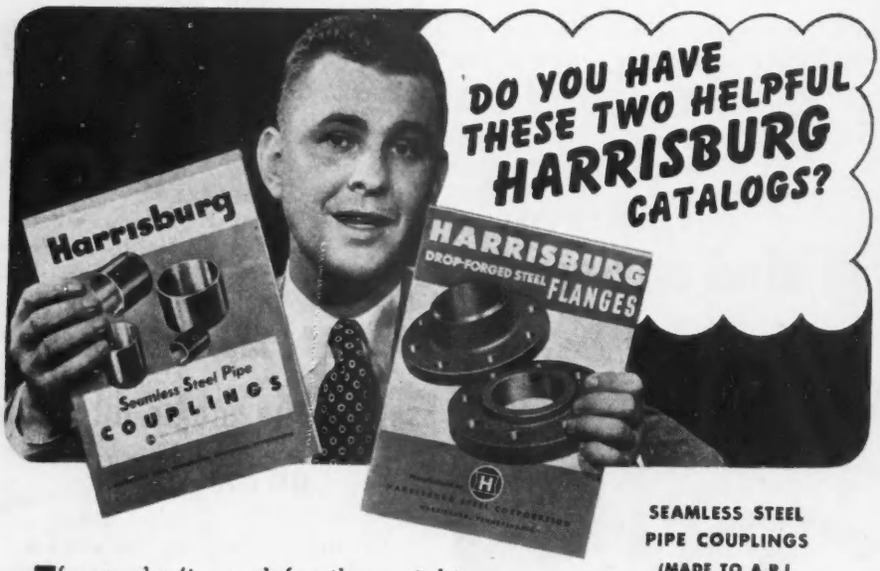
Dismantling the blowout preventer assembly on a well prior to moving the rig and assembling these units at the next well is a time-consuming job. Considerable savings in rigging up and tearing down time were made by skid-mounting the complete blowout preventer assembly as shown. Not only does this practice eliminate the long, tedious task of breaking out and making up all the bolts that hold the units together, but the problem of loading, unloading, and hauling these pieces of equipment is greatly facilitated.



The blowout preventer assembly illustrated consists of two ram-type preventers with a mud cross spaced between them. Skid runners were made of three-inch pipe and of sufficient length to span the outside dimensions, plus an additional length to support plate braces. Cross pieces of this same size pipe reinforce the skid at either end.

The skid was bolted to the blowout preventer assembly by means of metal plating which has been cut to fit over each end of one ram cylinder. This plate was welded down the center of the skid runner and serves to support the assembly during transit. A similar set of supporting plates have been attached to the lower preventer so that when the complete assembly is skidded onto a truck, it is adequately supported and little damage will result if the unit is handled roughly.

The skid is so attached that the rams of either preventer can be changed without interference. This assembly is left intact until repairs or a change in units is required. Little material is required in its construction, and great savings result from its use.



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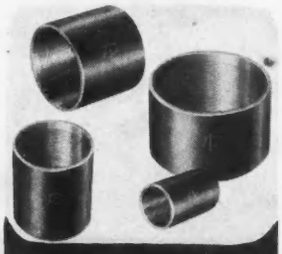

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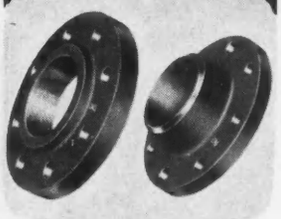

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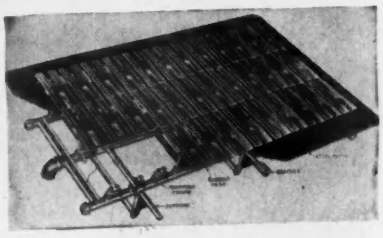

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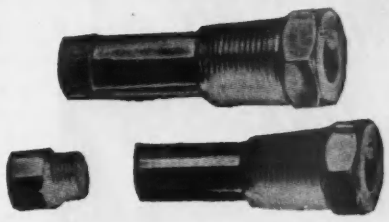

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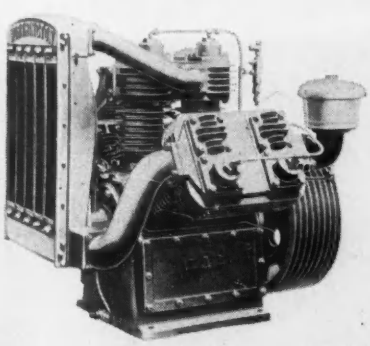

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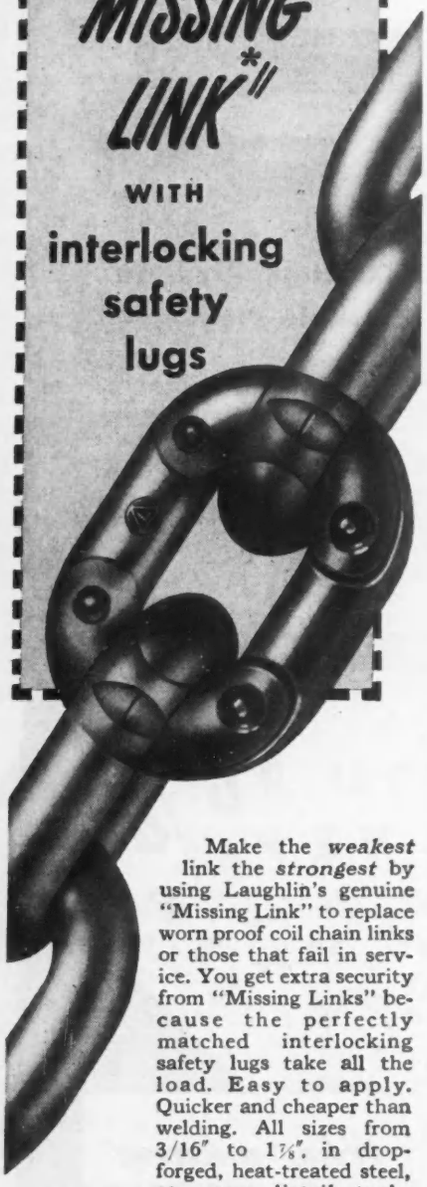

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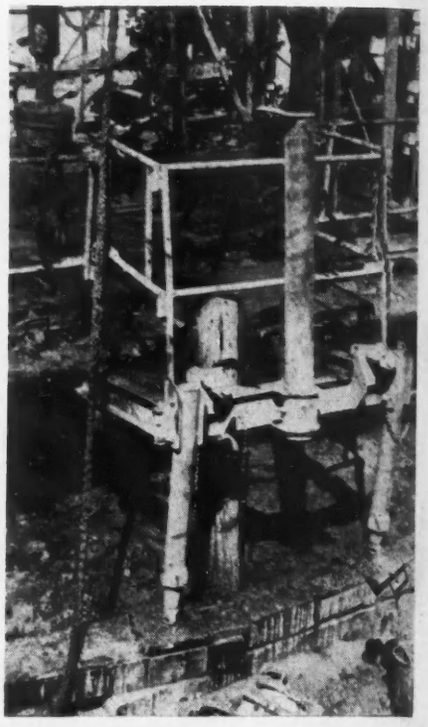
DRILLING HINTS

HOW TO—Offset Portable Rig Rathole

With portable drilling rigs that have small floor area, the kelly is frequently set to one side of the rig. To provide adequate means of controlling the movement of the kelly when lowering into the rathole, an apparatus is used which contains a post on which a catline sheave is mounted and a substantial frame which is connected to the floor sills of the drilling rig. Large I-beams form the side pieces, which connect the device to the derrick sills. An end piece carries a ferrule into which the post is set.

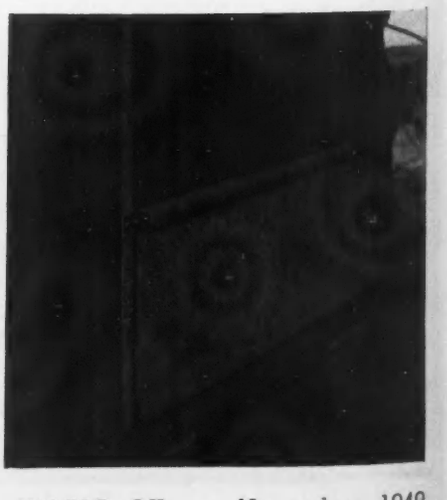
At each outer corner is a fitting which connects supporting posts that are detachable and have means for varying the length, including both the method of using holes and locking pins and screw jack heads set in the lower ends of the posts. Pins through matching holes in the leg ferrules provide for a long adjustment for height and can be used when cribbing is available which is of the correct thickness to level up. When closer adjustments are to be made, the screw jack shafts are used with the conventional base to lengthen or shorten this distance as the case may be.



HOW TO—Control Engine Temperatures

Both diesel and gasoline engines operate at peak efficiency at high temperatures. These operating temperatures vary somewhat with the make and type, but from a combustion efficiency point of view, the nearer temperatures can be held to boiling, the better. To maintain high temperatures on his diesel engines, in the winter months, one drilling contractor added a simple yet effective curtain which regulated the amount of cooling air passing through the radiator.

The canvas curtain was anchored at the bottom of the radiator grill as shown. Remainder of the curtain was coiled on a one-fourth-inch steel rod supported by two wire hooks that could be attached to the wire grille at any desired height. During the summer months when atmospheric temperatures are high, the curtain is lowered to the bottom. As the air begins to cool in the fall, the curtain is uncoiled part way up the radiator grille. During the coldest periods, the curtain may be almost all the way up, thereby covering the radiator grille with the exception of a small area. This curtain prevents the engine cooling fan from drawing cold air through the radiator coils to cool the engine water. In this manner, engine temperatures can be maintained around 160 to 180 degrees as desired.



BASIC CONSIDERATIONS of gas-lift principles are evaluated in their relation to the different types of apparatus available, and fundamental equations for determining operational characteristics are discussed by the author, and an alignment chart for the determination of efficiencies is appended.

Gas Lift Evaluation and Application

By KENNETH N. MILLS, Product Manager, Oil Field Sales, International Derrick and Equipment Company

GAS lift as a production method has a certain basic appeal to all production men, because, from an operational viewpoint, it is an extension of the natural flowing life of the well. The development of gas lift as a production tool has been gradual, and its development has followed the increase in knowledge of reservoir mechanics. The early gas lift systems employed the U-tube principle which is used to produce water wells with compressed air. This method was abandoned because it was inefficient. Also, in most instances it subjected the producing formation to adverse operating conditions, as it was not possible to control the producing gas-oil ratio.

Some of the disadvantages of the U-tube system were eliminated by the introduction of perforated collars to the tubing string. The perforated collar was located at some predetermined point above the end of the tubing string, and gas entered the fluid column through the perforations. In general this system was inefficient, because it was very difficult to determine the optimum location for the perforated collar. These disadvantages were gradually eliminated by the introduction of automatic flow valves. The early flow valves were controlled by gas or fluid velocity. Later this control system was replaced with valves which were controlled by pressure differentials between the tubing and the casing annulus.

The pressure differential type valves are applicable to large volume production as they can be operated on rapidly repeating cycles. Also, as the valve is controlled by pressure differential between the tubing and the casing, it does not require elaborate surface control equipment. However, one of the late developments in the field of differential pressure gas lift valves employs differential valves in conjunction with a casing pressure controlled valve on the flow line. In this system the differential valves are located on the outside of the tubing and the casing pressure is used to actuate the valve in the flow line. The flow line valve is set to open at a predetermined casing pressure and it closes when the casing pressure drops below that required to produce flow. When the flow line valve is open, the differential valves produce flow from the well. The casing pressure is re-established from the formation gas during the time the flow line valve is closed. This system of production is applicable to wells which produce relatively large volumes of gas and do not have sufficient bottom hole pressure to sustain natural flow.

This system is advantageous where there is sufficient gas in the oil to cause gas-lock if attempt is made to produce with a pump.

Surface Controlled Valves

To gain a higher degree of control over the admission of gas to the fluid column, surface controlled valves were developed. These valves have been developed around two types of control systems, and with each, it is possible to control accurately the time interval between gas injections, the length of time gas is injected into the fluid column, and the location of the gas injection point. One of these systems uses a number of valves spaced along the tubing at predetermined intervals which are actuated by a weight bar suspended on a wire line. The general layout of this system is shown diagramatically in Figure 1.

The design of the valves is such that they are open when the bar is in contact with the valve, and they are closed when the bar is withdrawn from the valve. The position of the weight bar is controlled by a small hoist at the surface, and it can be moved from valve to valve with this hoist. The action of the weight bar is controlled by a gas-actuated cylinder at the surface in conjunction with a time-clock controlled valve which admits and exhausts gas from the cylinder. As a constant gas pressure is maintained in the casing annulus, the frequency and duration of gas admission to the tubing is controlled from the surface, and it can be adjusted to obtain maximum efficiency. As the weight bar can be moved from valve to valve with the surface hoist, this system can be used to unload a well which has accumulated a high fluid head during a shutin period.

In the gas pressure controlled valve system the valve action is controlled by varying the casing pressure, and as the valve is located on the exterior of the tubing surface, it does not restrict the tubing bore. A cross-sectional drawing of one type of pressure controlled valve is shown in Figure 2. In this it will be noted that the valve stem is attached to a gas charged bellows. The gas admission valve is normally held closed by gas pressure in the bellows and a spring below the bellows. The pressure required to open the valve can be adjusted by varying the compression of the spring. Decreasing the initial compression of the spring will cause a reduction in the pressure required to open the valve, and increasing the compression will cause an increase in the opening pressure. When the valve is installed in a well, it will open and admit gas to the tubing string, if the gas pressure in the annulus exceeds the effective pressure of the gas in the bellows and the spring pressure. When the gas pressure in the annulus falls below the pressure required to overcome the bellows and spring pressure, the valve will close and stop the flow of gas from the annulus to the tubing string. Thus, the valve

action can be controlled from the surface by varying the casing pressure.

In a complete installation of pressure controlled valves, the valves are spaced along the tubing as shown in Figure 3. To obtain selective control over the action of each valve, the individual valves are set to open at different pressures. The top valve is set to open at the highest pressure and the opening pressures of the other valves are graduated downward. Each valve is set to open at a lower pressure. This prevents the upper valves from opening and admitting gas to the tubing when gas is being injected through a lower valve. The casing pressure is controlled by a time-clock operated valve which controls the admission of gas to the casing. As the control valve is time-clock controlled, the time interval between gas injections can be adjusted to obtain the most efficient rate of production by making adjustments at the surface. The point of gas injection can be controlled by adjusting the line pressure at the surface, and by manipulation of this control a well which has been shut in can be unloaded.

The type of sub-surface installation to be used in a given well will depend on the characteristics of the well. All of the well characteristics should be known before a well is placed on gas lift, because they are the prime considerations in determining the most desirable type of sub-surface installation. Basically, the various types of sub-surface installations can be classified as open- and closed-type installations. In an open-type installation, the gas lift valves are run on the tubing string without a packer or standing valve and without restrictions between the tubing and casing. As in this type installation the casing gas pressure is in direct contact with the well fluid, it holds a back pressure on the producing formation. For this reason the use of the open installation is limited to wells with relatively high bottom-hole pressures and high productivity indices compared to the anticipated rate of withdrawals. If the productivity index is low when compared to the rate of withdrawal, the fluid level may be reduced sufficiently to permit the gas to blow around the lower end of the tubing, causing excessive gas consumption.

In a closed installation, the lower end of the tubing is fitted with a standing valve, and the space between the tubing and casing is closed off with a packer above the producing formation. The packer and the standing valve form a seal, shielding the producing formation from the casing gas pressure. For this reason the closed type installation is applicable to wells with low bottom-hole pressures and relatively low pro-

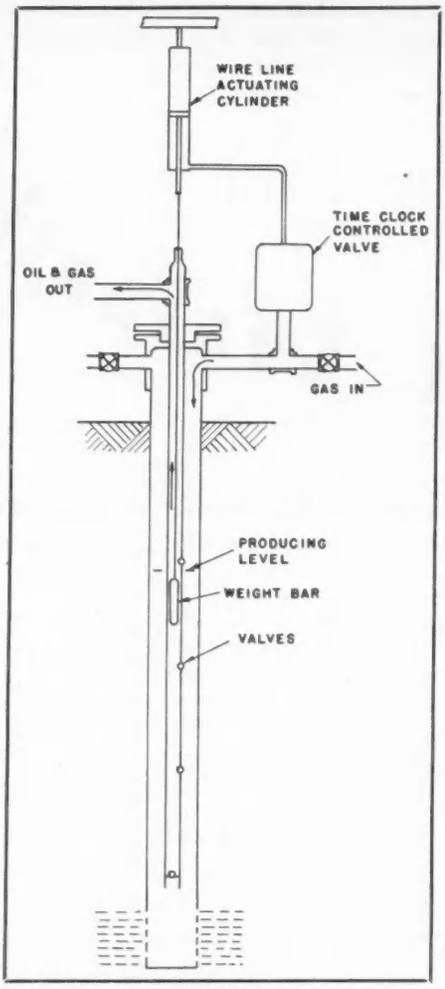


FIGURE 1

action can be controlled from the surface by varying the casing pressure.
ductivity indices compared to the rate of withdrawal. All of the gas lift valves in a closed system should be fitted with non-return check valves to prevent fluid from flowing from the tubing into the annulus during shutin periods. In a closed installation, it is important to keep the annulus dry, because it eliminates the necessity of unloading it after a shutin period. Also, it reduces the possibility of corrosion by corrosive well fluids.

To make a successful application of gas lift, it is necessary to have complete information covering the equipment in the well and the performance characteristics of the well. The information covering the well equipment should include the tubing size, casing size and weight of casing, setting depths, condition of casing and depth to producing formation. While all of this information is not pertinent in the design of an open installation, it is necessary in the design of a closed system to facilitate the selection and setting of the packer. To scientifically select and locate the gas lift valves, it is necessary to have the following information covering the characteristics of the well:

1. Depth to fluid level at maximum build-up with zero tubing pressure.
2. Static fluid gradient or weight of fluid column in pounds per square inch per foot of depth.
3. Bottom-hole pressure in pounds per square inch.
4. Productivity index in barrels per day per pound per square inch of bottom-hole pressure drop.
5. Natural shutin casing pressure in pounds per square inch.
6. Percent water produced.

In addition to the above information which is essential, additional information, such as gas-oil ratio, flowing casing pressure, trend toward water production, and degree of corrosiveness of well fluid will be a definite aid in designing a successful gas lift installation.

The surface gas pressure is the prime factor in determining the location of the top valve and the valve spacing. Basically, the minimum gas pressure must be sufficient to eject a column of fluid sufficiently long to keep slippage and wetting losses within reasonable limits.

A practical rule for determining the minimum gas pressure is that it should be at least 100 pounds per square inch per 1000 feet of lift and the minimum gas pressure should be 250 pounds per square inch regardless of lift. Naturally high gas pressures are desirable as they will promote greater efficiency due to the increased expansion permitting increased length of each slug.

The location of the top valve will depend on the maximum static fluid level and the ratio of the annulus area to the tubing area. While some authorities have stated that the ratio of annulus to tubing area can be neglected in an open installation, this assumption will not be true in all cases. The theory that the area ratio can be neglected is based on the assumption that fluid will be displaced back into the producing formation by the annulus gas pressure instead of being transferred from the annulus to the tubing. If the permeability of the producing formation is high, this type of fluid transfer may be achieved, but if the permeability of the formation is low, it is doubtful if a transfer of this type will be realized. Assuming that the fluid is transferred from the annulus to the tubing and pressure controlled valves are used, the submergence, i.e., setting distance of the top valve below the static fluid level can be calculated with the formula:

$$S = \frac{P_1 + P_2 - 100}{W\left(1 + \frac{A_1}{A_2}\right)}$$

where:

P_1 = Initial pressure in casing, pounds per square inch

P_2 = Increase in pressure used to open valve, pounds per square inch

W = Static fluid gradient, pounds per square inch per foot of depth

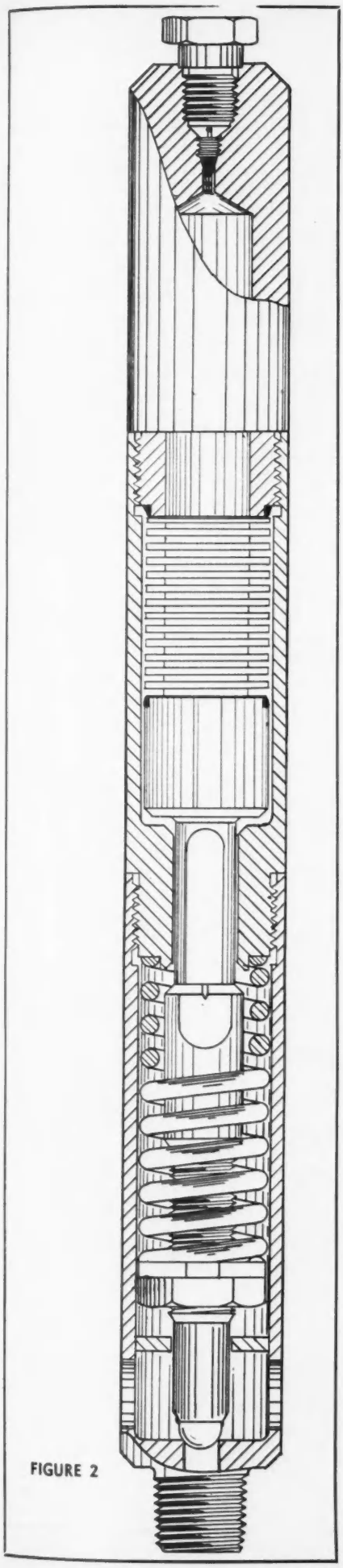


FIGURE 2

A_1 = Area of annulus, square inch
A_2 = Area of tubing, square inch
S = Submergence of top valve below maximum static fluid level, feet

If a wire-line controlled valve is used the formula becomes:

$$S = \frac{P - 100}{W\left(1 + \frac{A_1}{A_2}\right)}$$

where:

P = Casing pressure, pounds per square inch

When applying either type of valve, the submergence must be adjusted to suit full tubing lengths. In most instances, the adjustment should be made in a direction which reduces rather than increases the submergence, as this reduces the possibility of the system becoming stymied.

The spacing of the valves in a pressure controlled system can be approximated with the formula:

$$D = \frac{P_1 + P_3 - 100}{W}$$

where:

D = Valve spacing, feet
P_1 = Initial pressure in casing, pounds per square inch
P_3 = Pressure required to open valve under consideration, pounds per square inch
W = Static fluid gradient, pounds per square inch per foot of depth

In wells where great quantities of liquid must be lifted, the valves must be spaced progressively closer than indicated by the above formula.

Again, if the valves are wire-line controlled, the equation becomes:

$$D = \frac{P - 100}{W}$$

If the well makes water, even in small percentages, the valve spacing should be adjusted to operate with this heavier fluid. If a slug of water enters the tubing in sufficient quantity to create excessive tubing pressure at the valve, the system will either be very inefficient due to low starting velocity, or it will become stymied.

To achieve the maximum operating efficiency in a gas lift installation, it is desirable to understand the operating characteristics of this production tool. Basically, the wire-line and the pressure controlled gas lift systems are intermitters and the fluid is ejected from the well as a slug ahead of a gas piston. As the oil is intermittently ejected as a slug, a portion of the volume of each slug is lost wetting the walls of the tubing. As the thickness of the oil film is indeterminate, the magnitude of this loss cannot be accurately evaluated, but an analysis of the loss will suggest a means for reducing it. Considering a constant viscosity, the thickness of the film should be constant for any tubing size, and the magnitude of this loss should be a function of tubing diameter. Considering slugs of constant volume, it should increase as the tubing diameter is increased. The magnitude of this loss for various sizes of tubing and several assumed film thicknesses is shown in the table, which illustrates how this loss increases with tubing diameter.

Tubing Size, Inches	Loss in Gallons per 1000 Feet of Tubing With Film Thickness, in Inches, of:		
	0.025	0.05	0.10
2	8.26	16.26	31.69
2½	9.87	19.53	38.24
3	12.36	24.57	48.42

In addition to wetting losses, energy is lost by slippage back past the gas piston, gas blowing through the oil slug, and friction. Blow through losses are caused by insufficient length in the oil slug and are controllable by adjusting the intermitting cycle. Slippage losses are partially caused by insufficient velocity and can be reduced by using small tubing. Friction losses are a function of tubing condition and velocity and are difficult to evaluate. If the tubing is kept free of paraffin and the installation is properly engineered, friction losses should be kept at a minimum.

The efficiency of a gas lift system, assuming isothermal expansion, can be evaluated with the equation:

$$E = \frac{350\ BGL}{4860\ Q \log P_2/P_1}$$

where:

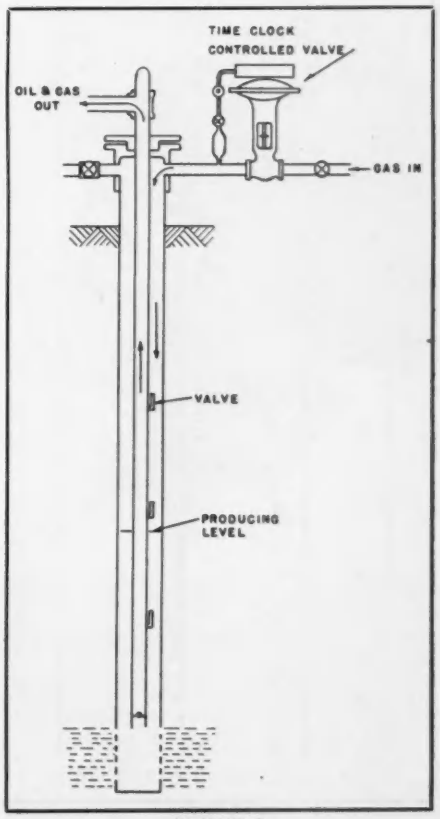


FIGURE 3

E = Efficiency expressed as a decimal
B = Barrels of oil produced
G = Specific gravity of the liquid produced
L = Depth to point of input of gas, feet
Q = Quantity of gas required to lift B in cubic feet at 14.65 psi absolute base pressure and at temperature of input gas
P_2 = Absolute pressure of input gas, pounds per square inch
P_1 = Absolute pressure of discharge gas, pounds per square inch

If the quantity of input gas is measured at any other temperature or pressure than the above standard, it can be converted to this volume with the equation:

$$Q = \frac{Q_1 P_1 T}{14.65 T_1}$$

where:

T = Temperature of input gas, absolute, degrees Fahr.
Q_1 = Quantity at absolute pressure P_1 and absolute temperature T_1

The efficiency of a gas lift system can be determined from the alignment chart shown in Figure 4. This chart is used as follows: Connect the value of B with a straight line to the value of L. Where this line crosses the blank pivot line connect with value of specific gravity of the fluid produced with a straight line. Then the theoretical work required to lift the liquid may be read where the second line intersects the W_r scale.

To obtain the work available in the gas in isothermally expanding from P_2 to P_1: connect the quantity of gas Q with a straight line to the value of P_2/P_1. Where this line intersects the W_a scale read the energy available from the gas. Then connect this last point with a straight line through the work required to lift the fluid and project this line to the E scale, read the percent efficiency of the gas lift system. This chart can be used to estimate gas requirements, if the over-all efficiency of this system is assumed and the total volume of fluid to be lifted is known.

ACKNOWLEDGMENT

The writer wishes to express his thanks to Paul Mills of Camco, Inc., for reviewing this paper and making valuable suggestions.

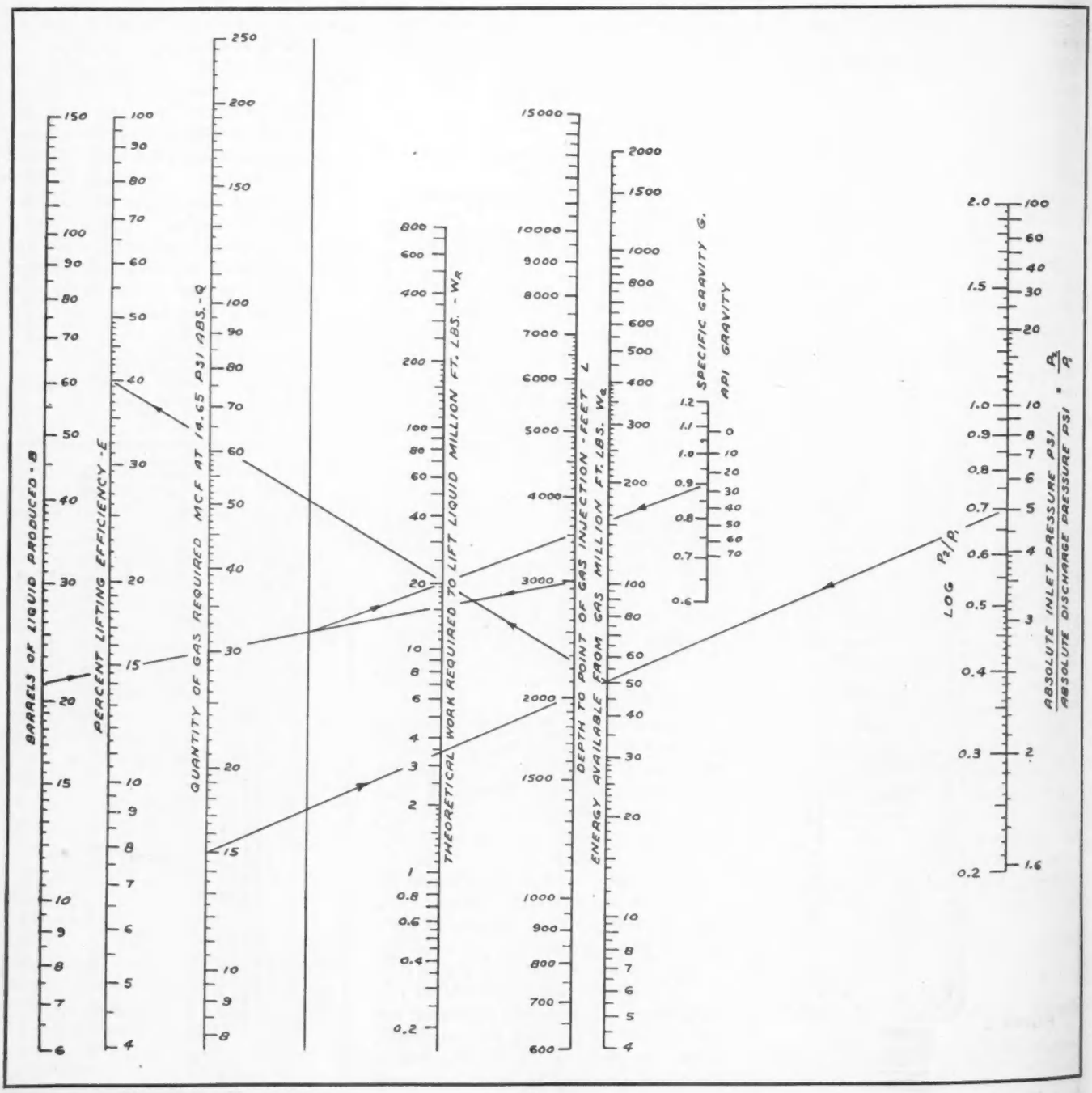

BARRELS OF LIQUID PRODUCED - B
PERCENT LIFTING EFFICIENCY - E
QUANTITY OF GAS REQUIRED MCF AT 14.65 PSI ABS. - Q
THEORETICAL WORK REQUIRED TO LIFT LIQUID MILLION FT. LBS. - W_R
DEPTH TO POINT OF GAS INJECTION - FEET L
ENERGY AVAILABLE FROM GAS MILLION FT. LBS. W_a
SPECIFIC GRAVITY G.
API GRAVITY
LOG P_2/P_1
ABSOLUTE INLET PRESSURE P2
ABSOLUTE DISCHARGE PRESSURE P1
$\frac{P_2}{P_1}$

FIGURE 4

One Minute Mr. Production Man

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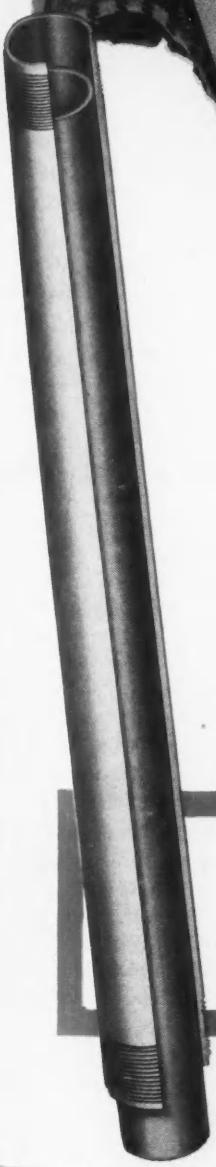

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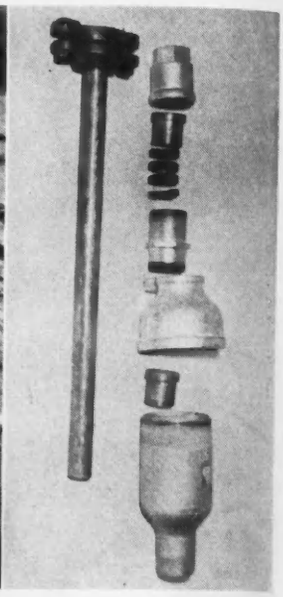
Field Men Devise Stuffing Box



By W. H. FOWLER
North Texas Division,
Shell Oil Company

FIGURE 1 (left). Modified, self lubricating well head stuffing box.
(Photograph courtesy Shell Oil Company)

FIGURE 2 (right). Component parts of the self lubricating stuffing box, with all parts except the actual packing container made up from standard pipe fittings.

SINCE oil was first brought to the surface with a sucker rod pump the stuffing box at the well head has been a source of annoyance, trouble and expense. Wells particularly prone to have leaking, troublesome stuffing boxes requiring considerable attention are those of relatively small fluid capacity which come under one or more of the following classifications:

1. Wells that produce sufficient gas to partially flow. When the pumping unit is shut down a head of gas builds up under the oil column in the tubing causing the well to flow or blowoff soon after pumping is resumed.
2. Wells that pump off long before it is practical to stop the unit, such as wells on central powers.
3. Wells that have leaking pump valves or leaking tubing which allow the oil column in the tubing to drain out when the unit is shut down.
4. Wells in which gas interferes with the pump valves to prevent fluid from entering the pump for intervals of as much as 30 minutes to one hour at a time.

In short, any condition which causes dry operation of the polished rod will wear out and burn out the stuffing box packing and cause frequent replacement of packing rings, dirty well locations and loss of oil and gas.

In Shell Oil Company's North Texas division field men for the past three years have studied means to develop a suitable and economical stuffing box. Various types of standard boxes were tried with mediocre success. They experimented with wax paper above the packing rings and with wax coated rings on the theory that the wax would melt when the rod warmed up and automatically supply lubrication as needed. Drip lubricators and boxes equipped with oil reservoirs welded to the top were used with some success. However, excess oil clinging to the polished rod was blown off, making locations dirty. In addition, frequent filling was required to assure lubrication. This effort resulted in the development of three successful stuffing boxes: a modified lubricated box in the Joy district, a self-lubricating box in the Pampa district, and a box combining the desirable features of the first two at reduced cost.

Economical Feature

Figure 1 shows an installation of the modified self-lubricating box on a pumping well. The box has the oil chamber on the bottom. With the waste-packed oil chamber below the rubbers, the self-oiling feature is obtained very economically. All modification parts for the combination box are standard oil field fittings, simple and inexpensive with the total cost of the assembly under $8.

The stuffing box consists of a 4- to 2-inch swedge fitted at the two-inch end with a standard lead stuffing box follower. At the four-inch end of the swedge a standard 4- to 2-inch reducer coupling is made up onto the swedge. The volume inside the chamber formed by the swedge and the reducer is filled with cotton waste which is continuously saturated with crude oil from the well through the loosely fitted stuffing box follower. Above the reduced coupling a standard stuffing box is screwed into the two-inch end of the reducer coupling (Figure 2).

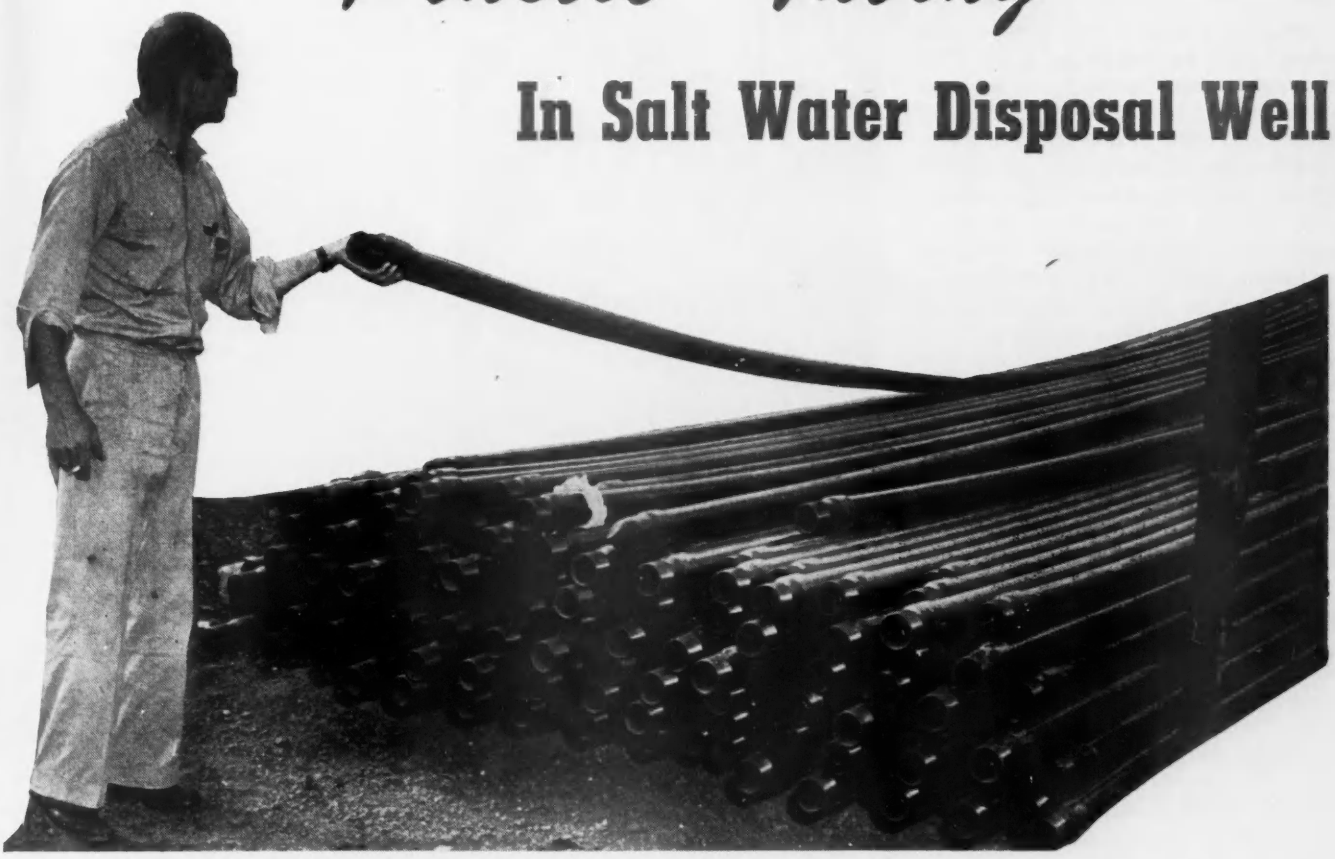
In operation, a film of oil is maintained on the rod, lubricating the packing rings and prolonging their life many weeks. Appreciable wastage of oil and gas through stuffing box leakage at the wellhead is a rarity and cleanup of locations can be handled by the pumper in a matter of a few minutes per month. The self-lubricating feature has worked most satisfactorily, eliminating hand oiling and preventing dirt and hardening of the oil saturated waste from adversely affecting its lubricating qualities.

Since early 1948 this self-oiling stuffing box has been used exclusively in Shell's Joy and Antelope fields on all new wells and for all replacements. During this period 20 new wells have been put on the pump and approximately 30 box replacements on old wells have been made.

By the use of this self-lubricating box the time interval for packing ring replacement has been reduced in many instances from twice in one week to once in three months. On intermittently pumped wells which had previously required an excessive amount of stuffing box attention, the $8 total cost of the box has been returned in less than one year from savings in packing rings alone. Decreased oil and gas waste and reduced maintenance labor represent estimated annual savings of approximately $100 per well.

Plastic Tubing

In Salt Water Disposal Well



Lightness and flexibility of all-plastic tubing is demonstrated as bystander easily picks up a 20-foot joint with one hand.

By ANTHONY GIBBON
Mid-Continent District Editor

A RECENT successful installation of a complete string of 3387 feet of all-plastic tubing in a salt water disposal well on the Harbecek lease of National Cooperative Refinery Association in Western Kansas was run by the Green Contracting and Engineering Company, Inc., Wichita, Kansas, and is indicative of the extent to which light weight, low tensile materials—if of non-corrosive composition—may be utilized.

This type of all-plastic pipe was first applied in the oil industry in April, 1949, in fields in Kansas, Illinois, Oklahoma and Texas as a material suitable for use in low pressure transmission lines handling sour crude, paraffin crudes, raw gas, and fresh and brine waters. In general it is immune to the effects of dilute acids and alkalis, organics (with the general exception of chlorinated solvents and aromatic hydrocarbons), and it is unaffected by corrosive soil conditions. It "welds" into a completely leakproof line, is easily and rapidly installed, and hence is an ideal material for lead, flow or disposal lines on production properties where corrosion, either internal or external, or solid depositions are factors.

SUCCESSFUL RUNNING of a string of plastic tubing to a depth of nearly 3800 feet indicates the advances made in the production of this light-weight, corrosion resistant material. The author describes the manufacture of such tubing, and outlines steps necessary for satisfactory service.

Weathering or aging is good and on buried lines excellent, as indicated by experience records covering five years of service in low pressure gas lines with no apparent deterioration.

The basic material in this pipe, designated as Carlon "B," is a special grade of cellulose acetate butyrate, selected for maximum impact and tensile strength and satisfactory aging qualities, which is further compounded at the time of extrusion to form a semi-rigid, tough, high tensile, non-corrosive product with the physical qualities enumerated in Table 1.

Temperature Range

The materials are recommended for a working temperature range of —40° F to 140° F, although it will be noted from Table 1 that impact strength is materially reduced at low temperatures;

and from the accompanying graph, that tensiles are decreased by each degree of temperature increase.

Plastic Line Pipe

Standard plastic line pipe can be strung, made up and placed in the ditch in much the same manner as steel pipe, although with considerably less equipment and at a fraction of the cost (actual stringing and make-up time with a three-man connection gang averages 1200 to 1500 feet per hour on three-inch). In most instances, the line should be buried; however, no special grade is required under average soil conditions, or special precautions taken in backfill, as its flexibility permits the pipe to follow the contour of the earth. However, in rocky terrain or on deep cuts, care must be exercised to protect the pipe from fractures; and at road or lease crossings where heavy traffic is contemplated, the pipe should be run in conduit.

A leakproof joint is facilitated by the use of a slip sleeve coupling which comes cemented to one end of the pipe and into which the male end of the next joint is inserted after being coated with a cold weld plastic cement that welds the sleeve and the pipe into one integral unit. The speed and ease with which make-up can be made, along with length of joint (20-foot average) and extreme lightness to a large extent account for the unusually large amount of line that can be handled per hour. Standard threaded adapters for going from plastic to steel connections are available and may be run up with standard pipe wrenches.

All-plastic pipe being lowered in the hole at National Cooperative Refinery Association's salt water disposal well on the Harbecek lease in Ellsworth County, Kansas.

The extra heavy plastic tubing combines all the chemical and physical properties of the standard plastic line pipe and has the added mechanical features of upset male and female adapters and standard length threads that permit its being handled with standard tools (slips—elevators and chain tongs). Hence, there is very little difference, or special equipment required, in running this tubing, although some care must be exercised to prevent cross threading due to the gasket-like characteristic of the material. Due to the extreme light weight and semi-buoyancy in brine waters, heavy service equipment is not necessary. As an example, the string which was run in the Harbecek lease well weighed only 1½ tons, whereas a comparable string of three-inch cement lined steel tubing with like capacity would have weighed approximately 17 tons.

Manufacture of Pipe

As the manufacture of plastic pipe in an extreme seamless form, particularly on sizes larger than two inches, is a revolution within itself but with the proper technique results in a finished material with tolerances comparable to steel, it might be well to point out that while it necessarily embodies the use of standard extrusion equipment and base raw materials used in the extrusion of thousands of commercial items of every description, the "know-how" after it leaves the extruding machine is as exacting as that of a "glass blower" and the materials—because of their complicated and multiple formulations—are many times as tricky as glass. Nevertheless that those not familiar with the extrusion of plastics may visualize the operation, fundamentally it might be described as follows:

First, the plastic compounds, in pellet, powder, granular and strip form are dehydrated in controlled material dryers. They are then placed in the feed hoppers on the extrusion machine and are from there conveyed into and through the heating cylinders where they are heated or melted to the proper temperature for proper plasticizing and are then extruded at high pressures through the forming die or head into the size and shapes desired; then, as it comes out of the extrusion head and over the conveyors, it is normalized and cooled, this latter operation, particularly with regard to difficult or large shapes, requiring the real "know-how" and rigid control.

Cost Factor

In the manufacture of plastic pipe, as with most other innovations, the costs of producing raw materials and processing of the basic material into manufactured goods is necessarily high in comparison to materials commonly used for a like purpose. However, as supply and demand increase, it is reasonable to assume that over-all costs will correspondingly decrease, so that whereas plastic pipe currently must be analyzed from several different angles to justify its economical use, it may be anticipated

TABLE 1

Physical Properties—Carlon "B"

Specific Gravity 1.18 5%±
Impact Strength IZOD ft. lb. per inch notched —40° F. 5, 77° F. 1.2
Tensile Strength @ 77° F. psi 4400 lbs. 158° F. psi 3000 lbs.
Tensile at First Signs of Stretch 77° F. psi 3000 lbs
Flexural Strength at Yield 4800 lbs psi 77° F.
Compressive Strength at Yield 3600 lbs psi 77° F.
Thermal Expansion (average) 6.1—9.4x10^{5} inches per °F.
Burning Rate—Slow
Water Absorption—24 hour/⅛"—1-2%
Modulus of Elasticity—2x10^{5} psi (tension)
Sunlight Resistance—Excellent
Dielectric Strength—400 volts per mil in ⅛" thickness

STANDARD SIZES

SIZE	Approximate Wt. per Ft.	Nominal I.D.	Nominal O.D.	Calculated Burst Pressure Psi.
2" Standard Line Pipe	.45	2.00	2.25	550 lbs
3" Standard Line Pipe	.63	3.00	3.25	300 lbs.
4" Standard Line Pipe	1.01	4.00	4.30	300 lbs.
5" Standard Line Pipe	1.60	5.00	5.36	375 lbs.
6" Standard Line Pipe	2.35	6.00	6.46	300 lps.
2" Threaded Tubing	.672	2.00	2.37	900 lbs.
2½" Threaded Tubing	.826	2.50	2.87	900 lbs.
3" Threaded Tubing	1.33	3.00	3.50	600 lbs.
4" Threaded Tubing	2.44	4.00	4.67	600 lbs.

JENSEN relieves the Load on Your "Out-go"

Production profit is the difference between your "Income" and "Out-go."

The part of "Out-go" chargeable to pumping unit operation and maintenance is the part that interests your Jensen dealer. Through his experience and the efficiency of the unit he handles, he can—in most every case—relieve the load on the "Out-go." This increases your production profit which is an interesting subject to every oil man of our acquaintance.

Incidentally, we'd appreciate an opportunity to acquaint YOU with facts and figures on Jensen units. Either write to us in Coffeyville for free literature or see your local dealer. Do it today.

JENSEN

Bros. Mfg. Co., Coffeyville, Kan.

Export Office: 50 CHURCH STREET, NEW YORK CITY

that it will eventually take its place as a common everyday commodity as supply and demand lowers the cost of manufacture.

Manufacturing facilities for the production of the plastic line pipe and tubing extrusion are limited and this fact, of course, influences the cost factor. Some operators feel that the initial cost is too great to warrant its use where corrosion conditions are not too severe. Others, however, indicate that when it is taken into consideration that conventional pipe subject to corrosive conditions must also be treated or lined with a protective coating, the cost comparison is not too great. Another economic feature of plastic pipe and tubing is its extreme light weight, which cuts down transportation costs, and its fast make-up, reflected in time saved.

Limitations

Operators (and manufacturers) are inclined to experiment or use a new material that shows merit, as though it were a panacea. Before going beyond the limitations of the material as represented by its known chemical resistance and physical properties, it will be well for the operator to weigh the subject carefully and make any such applications as a calculated risk. With reference to the specific materials covered in this article, it might be well to point out that they are designed for use primarily as low pressure lines and where a reasonable safety factor with regard to strengths can be assured. In addition, temperatures have a very definite bearing on their serviceability and allowance must be made for expansion and contraction in excess of that required on steel. Lastly, unnecessary rough handling or literally "throwing" the pipe around can result in an unwarranted condition of pressing the pipe beyond its physical endurance, resulting in unsatisfactory service.

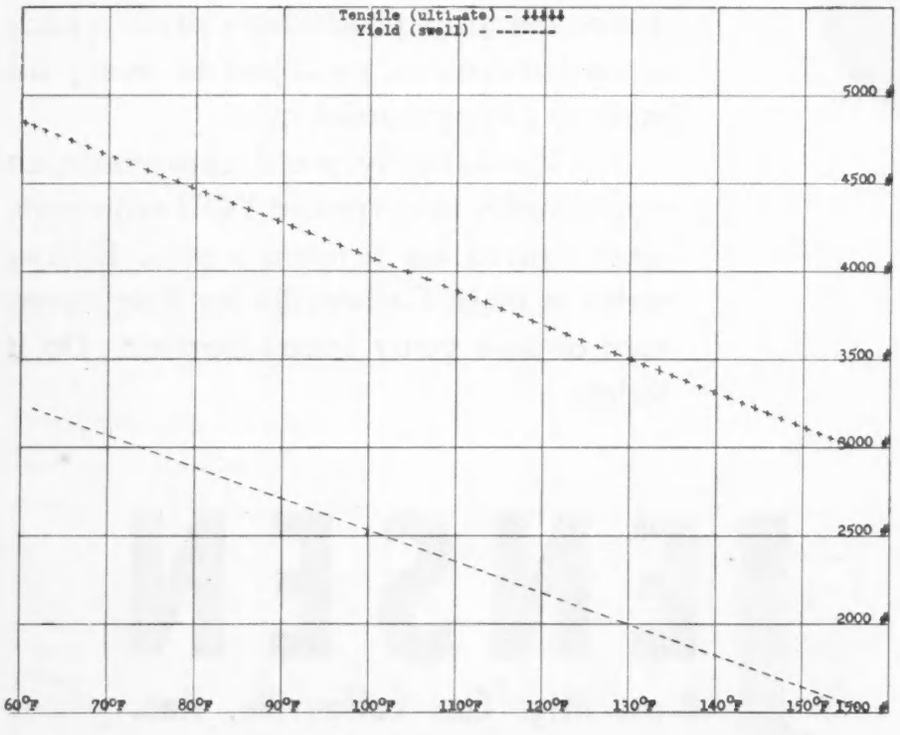
Handling Instructions

Due to its extreme light weight, more than ordinary precautions must be taken in the handling and making up of extruded plastic pipe. It should be transported on flat bed trucks, or supported in much the same manner as rods or other flexible oil field goods, and if boomers are used, it should be protected from chains. The pipe should be stored on elevated platform type racks preferably weather protected if storage is to be for any length of time. It may be loaded or unloaded in much the same manner as steel pipe and it should be strung in the same manner, although care must be taken to lay, not throw, the pipe in the ditch. No special grade is required under average soil conditions or special precautions taken in backfill. However, in rocky terrain some care must be exercised in making the backfill.

Make-Up Procedure

The cold weld cemented type slip sleeve is recommended for fastest and safest method of pipe make-up, using special solution and thinner, and should assure a continuous leak-proof line, and with the coupling once cemented and cured, will become an integral part of the line itself.

The coupling and pipe to be cemented must be clean and dry. The male end of the pipe should be coated liberally by brush with the solution for a distance equal to the depth of throat in the coupling. At the same time the throat of the coupling should be painted with the thinner, which should be liberally applied to soften the internal surface of the coupling and make it receptive to the welding cement, which is the consistency of heavy syrup. Immediately after applying welding cement and thinner the operator should insert the pipe in sleeve, pushing up firmly until the end of the pipe is against the end of the opposite length of pipe. The joint will be strong enough for careful handling in from two to three minutes, and for stringing in the ditch in from one to two hours, but it does not reach full strength for about 24 hours. The best joints are made by giving the pipe a one-half turn immediately after inserting in sleeve. Caution should be taken to butt the male end firmly into the sleeve until it is in contact with the opposite joint as a joint only partially made up can result in a break under side thrust or strain as this is the most rigid point in the line.



Tensile vs. temperature—Carlon B.

Properties

Properties claimed for extruded plastic pipe include chemical resistance to most alkalines, salts, acids and hydrocarbons encountered in oil production, or acid and alkaline soil conditions.

Less friction loss due to dense, slick, streamlined internal surface.

Decrease in deposition of solids, as paraffins, asphalts, or acid and alkaline produced salts do not readily adhere to the pipe.

Weathering and aging are very good, and excellent on buried lines.

Provides a leak-proof line by the use of the cold weld cemented sleeve joint, with the joint having twice the strength of the balance of the line.

Its compressive, impact and flexing strength are sufficient for any normal operation requiring a non-corrosive line for gravity and low pressure flow of crude oils, raw gas, salt water, sour crudes, gasoline or fresh water.

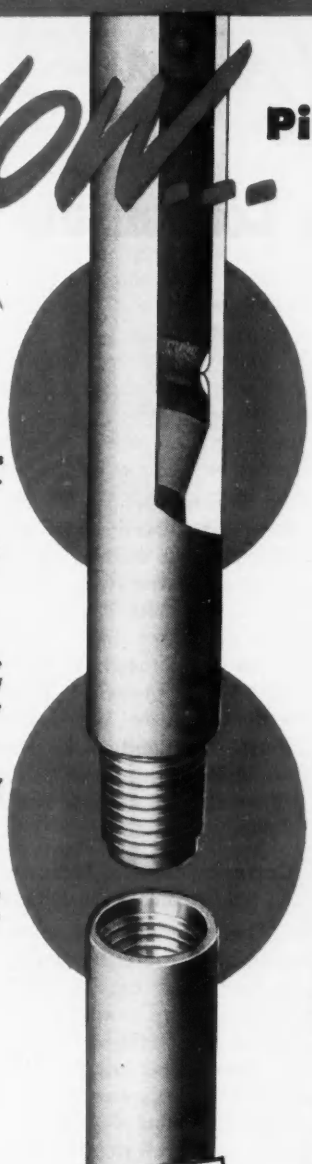
Baash-Ross News

BAASH-ROSS TOOL COMPANY • LOS ANGELES • HOUSTON • OKLAHOMA CITY • NEW YORK

OUR 29th YEAR

Now—

Pipe strings specially designed for today's deep-well cutting, clean out and other small-pipe operations . . .



FLASH WELDED JOINTS

Eliminate weaknesses of ordinary joint-to-pipe connections!

UNUSUALLY HIGH STRENGTH

As much as 3 times the tensile and torque of other strings with the same diameter!

EXTERNALLY FLUSH DIAMETER

Assures free passage through other pipe without hanging up!

Baash-Ross *High Strength* Small-Diameter PIPE STRINGS!

To match the deep well performance of Baash-Ross Cutting and Fishing Tools and Baash-Ross Power Swivels, Baash-Ross can now supply you with a new type of small-diameter pipe strings which feature unusually high strength factors—*both in tensile and torque!*

THE HIGH OVERALL STRENGTH IS ACHIEVED THROUGH THESE IMPORTANT FACTORS . . .

1 HIGH STRENGTH PIPE:
The pipe itself is made from chrome-molybdenum alloy steel tubing that is cold-drawn and normalized to provide very high strength-to-weight ratios in the pipe sections themselves.

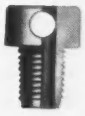
2 HEAT-TREATED TOOL JOINTS:
The tool joints are also made from alloy steel that is specially heat-treated to combine wear-resisting hardness with shock-resisting toughness and strength. The tool joints are internally upset to provide ample metal for the threads, and the thread pattern has been carefully engineered to combine high strength with easy make-up.

3 FLASH WELDED CONSTRUCTION:
The final step to insure all-around high strength is the unique method by which the pipe is joined to the tool joints. A specially-developed flash-weld process is used that not only joins the tool joints *directly* to the pipe (eliminating any threads or other weak points between pipe and joints) *but provides a weld section that is actually stronger than the pipe itself!*

RESULT—a small diameter, light weight pipe string with unusually high strength properties . . . minimum tensile, 100,000 lbs./sq. in.—minimum torque, 47,500 lbs./sq. in!

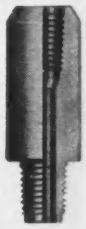
Completely Flush Outside Diameter In addition to small diameter, low weight, and unusually high strength, Baash-Ross Small-Diameter Pipe Strings also feature a completely flush outside surface with no bulges or increased diameters to hang up or cause difficulties when working inside of other pipe strings. Note that there are no external beads or projections of any kind at the welded joint—and the tool joints are of the same outside diameter as the pipe—thus assuring an absolutely flush surface at all points.

Accessory Equipment To insure maximum adaptability and convenience in using Baash-Ross Small-Diameter Pipe Strings, the following accessory equipment is also available . . .



ELEVATOR PLUGS
These plugs are inserted into the top joint of the Small-Diameter Pipe String to provide a convenient elevator shoulder for supporting the string and handling the flush pipe sections. Made of heat-treated and hardened alloy steel, these Plugs are available with male thread only.

STABILIZER SUBS
Operators use these between the joints of Small-Diameter Pipe Strings to provide stabilizing shoulders that reduce friction on long cutting strings when working inside of internal flush pipe. (When working inside internal upset pipe, the upsets themselves provide stabilization and no stabilizing Subs are used.) These Subs are made of heat-treated and hardened alloy steel—and are sufficiently larger in diameter than the pipe to provide an elevator shoulder for supporting and handling the string. They are removed only when the pipe is used inside of other strings where clearance restricts the use of Stabilizer Subs.



Wide Adaptability Baash-Ross Small-Diameter Pipe Strings are unusually adaptable to virtually any small-pipe operation—for operating cutting strings, rotating small bits, clean-out tools, etc. . . . and they are the ideal pipe string to use with the popular Baash-Ross Power Swivel, which more and more operators are adapting to a wide variety of light rotating operations.

The Strings are externally flush, so can be run with complete safety inside all types of pipe—even internal upset pipe. They are available in a full range of sizes, but the most popular size is 1.660" in outside diameter. This size has the greatest range of adaptability since it can be run inside of any of the sizes of tubing or drill pipe indicated in the panel at left. ***Write for full details!***

The most popular size of Baash-Ross Small-Diameter Pipe—1.660" O.D.—can be run inside any of the following sizes of tubing or drill pipe . . .

TUBING:

2" E. U. or 2" Plain — and larger.

DRILL PIPE:

2⅞" A.P.I. "IF"
3½" A.P.I. "FH" and "IF"
4½" A.P.I. "Regular," "FH" and "IF"
5½" A.P.I. "Regular," "FH" and "IF"
6⅝" A.P.I. "Regular," "FH" and "IF"

Baash-Ross offers a complete range of Small-Diameter Pipe Strings for both sales and rental purposes. Prices, specifications and physical test data will gladly be supplied on request to our nearest office.

Field and Laboratory Tests of

Sodium Chromates and Alkalies

for Controlling Corrosion in Gas Condensate Wells

Part 5 —(OF SIX PARTS)

ANALYSIS OF FIELD TEST RESULTS

By

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FIGURE 17 was prepared to provide a graphical summary of part of the data illustrated in Figures 9 to 16, inclusive, with other information helpful in an appraisal of results obtained during the 20 months that tests were under way at the well in the Cotton Valley, La., field. Sections H, I, and J in the approximate center of Figure 17 show, as a function of time, what materials were injected into the well to lower rates of corrosion. Sections A to G, inclusive, show significant changes in the properties of the effluent water and corresponding measures of the resultant corrosion control. Sections K, L, and M show the effect of the treatments on the flow capacity of the tubing.

Section H of Figure 17 is similar to Section E of Figures 9 to 16, inclusive, but the volume of water injected is referred to a million cubic feet of gas produced rather than to a day of production. Because of the shortening of the time scale, the record of the volumetric rates of injection could not be as detailed as the daily records in Figures 9 to 16. The same limitation applies to some extent to representation of changes in values of all the other factors illustrated in Figure 17.

The chromates and alkalies used in the test treatments of the well are named in Section J between lines indicating the approximate time interval during which they were used. The weight of each material injected into the annular space of the well to flow upward through the tubing with each million cubic feet of gas produced is shown by ordinate values of curves over the cross-hatched areas in Section I. Sodium chromate injections alternated with water wash procedures were tested first. Sodium hydroxide was mixed with sodium chromate to increase the pH of the flowing water for a second series of tests. Sodium dichromate was injected into the well at different rates to provide chromate solutions of low pH for a third series of tests. The tests that were made to determine the effect of the pH of the water on the rate of reduction of chromates were concluded by injecting chromic acid into the well to decrease the pH of the effluent water to values as low as 4.9. As shown in Section H, the rate at which water was injected into the well was varied throughout the tests to determine the effect of injection rate on the reduction of chromates and the retention of solids in the tubing.

The pH of water from the tubinghead, measured at atmospheric pressure, is shown as a function of time in Section A of Figure 17. When solutions of sodium chromate were being injected, the pH of the effluent water averaged 7.0. The pH increased to an average of 7.7, when sodium hydroxide was injected with sodium chromate, and then decreased to an average of 6.4 when sodium dichromate solutions were used. An average pH of 5.1 was maintained for the relatively short interval of time that chromic acid was used in the flowstream of the well. As discussed in connection with Figures 6, 7, and 8, the pH values of the effluent water are probably somewhat higher than the values that prevailed in the flowstream under pressure and are affected to a considerable extent by the presence of dissolved compounds other than the chromate and alkalies used in the treatments.

Corrosion Control Indicated by Presence of Chromates in Effluent Water

The times when chromates were present in the effluent water are shown in Section D of Figure 17. In most of the tests, the quantity of chromates injected per million cubic feet of gas produced was controlled so that there would be only enough remaining in the effluent water to give it a yellow color after most of the chromates had been reduced or otherwise consumed while the fluid was flowing upward through the tubing. As shown by sections B and D, there is a close correlation between the rates of corrosion of coupons exposed to the flowstream in the wellhead and the presence of chromates in the effluent water. If chromates were not present in the effluent water for considerable periods of time, the rate of corrosion of coupons tended to increase as it did during September and October, 1946. When the rate of injection of chromates was increased on October 26, the rate of corrosion of coupons began to decrease, and by November 3, when an abundance of chromates appeared in the effluent water, the rates of corrosion were negligible. In general, sections B and D show that the rate of corrosion of a wellhead

coupon is low (less than 0.004 inch penetration per year) when the concentration of chromates in the effluent water is high enough to give the water a definite yellow color (approximately 50 parts per million).

Data illustrated in Section C show that concentrations of iron in the effluent water can be maintained at low values although not enough of a chromate is injected into the casing to maintain an appreciable excess of chromates in the water at the tubinghead. The degree of concentration of iron in the effluent water is an indication of the rate of corrosion occurring in some part or in the full length of the tubing, and when an inadequate quantity of treating material is injected into the well the bottom end of the tubing where the material enters the flow stream may be fully protected, although the upper part of the tubing may receive only partial protection. Under such conditions of treatment, the upper part of the tubing and the christmas tree fittings may lose some iron to the flowing water. The relatively low iron concentrations found in the effluent water during September and October, 1946 (Section C, Figure 17), are examples of the incomplete protection afforded the well when it was treated with 0.3 pounds of sodium dichromate per million cubic feet of gas The data given in Section C show that only traces of iron are present in the effluent water when enough chromates are present to give it a yellow color, and that concentrations of iron in the flowstream can be greatly reduced even when the quantity of chromates injected into the well is not enough to provide an excess of chromates in the water at the tubinghead.

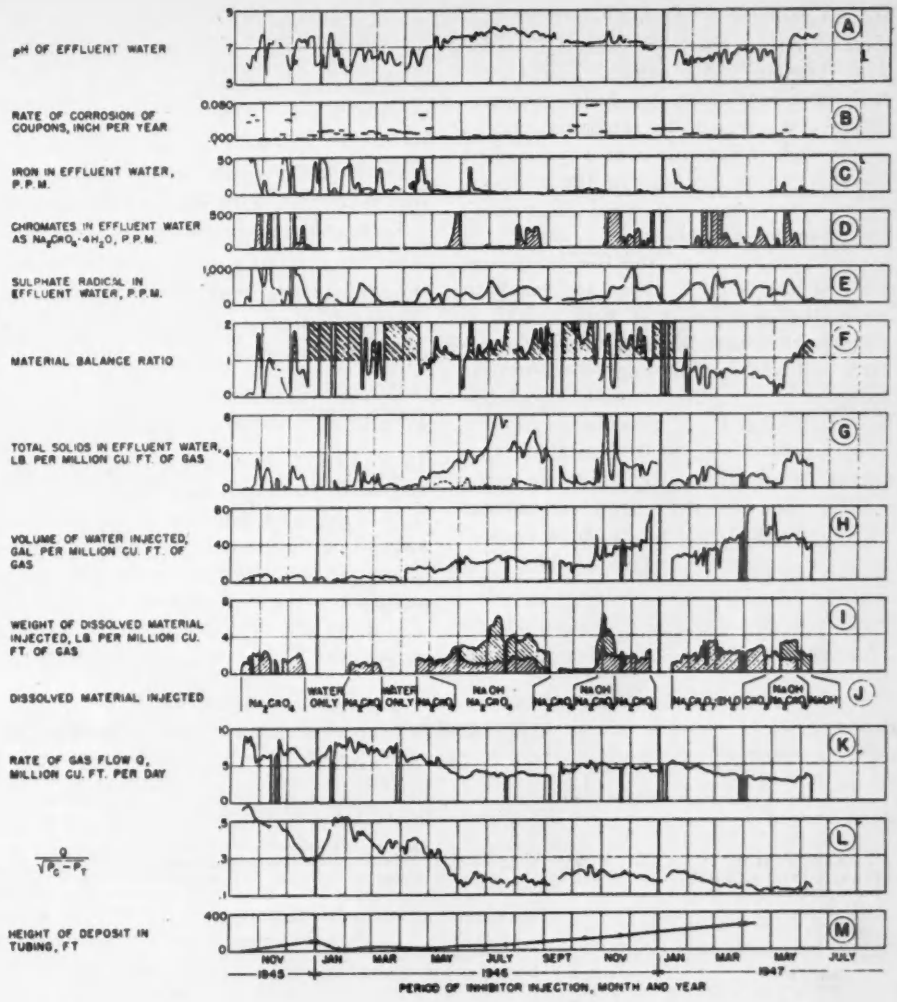
pH OF EFFLUENT WATER
RATE OF CORROSION OF COUPONS, INCH PER YEAR
IRON IN EFFLUENT WATER, P.P.M.
CHROMATES IN EFFLUENT WATER AS $Na_2CrO_4 \cdot 4H_2O$, P.P.M.
SULPHATE RADICAL IN EFFLUENT WATER, P.P.M.
MATERIAL BALANCE RATIO
TOTAL SOLIDS IN EFFLUENT WATER, LB. PER MILLION CU. FT. OF GAS
VOLUME OF WATER INJECTED, GAL. PER MILLION CU. FT. OF GAS
WEIGHT OF DISSOLVED MATERIAL INJECTED, LB. PER MILLION CU. FT. OF GAS
DISSOLVED MATERIAL INJECTED
WATER ONLY
NaOH
RATE OF GAS FLOW Q, MILLION CU. FT. PER DAY
$\frac{Q}{\sqrt{P_C - P_T}}$
HEIGHT OF DEPOSIT IN TUBING, FT
NOV JAN MAR MAY JULY SEPT NOV JAN MAR MAY JULY
1945 1946 1947
PERIOD OF INHIBITOR INJECTION, MONTH AND YEAR

FIGURE 17. Summary of tests of sodium chromates and alkalies for controlling corrosion in a gas-condensate well, Cotton Valley Field, La.

Material-Balance Ratio

Section G of Figure 17 is a graphic representation of the weight of chromium compounds, bicarbonates, and other salts carried to the surface in the flowstream either in solution or in suspension. As discussed earlier in this report, it was calculated that 55 gallons of water condensed in the tubing of the test well from the amount of flowing fluid containing a million cubic feet of gas by the time the fluid reached the tubinghead. The volume of water injected into the well per million cubic feet of gas is recorded in Section H of Figure 17. The sum of the volumes of injected and condensed water is the volume of the water that carried dissolved and solid material to the surface and which was sampled and analyzed by evaporation each day for its "total solids" content. Assuming a satisfactory accuracy in the sampling, the analysis, and in the estimation of the total volume of water produced with each million cubic feet of gas, data in Section G represent a recovery of solids which may be compared with the input of solids recorded in Section I.

Reactions between injected chemicals in solution and substances in the reservoir fluid to form compounds which become part of the "total solids" and which have greater or lesser weights than the injected materials preclude attainment of an exact balance between materials injected into the casinghead and "total solids" by evaporation recovered with the effluent water. The reaction between injected sodium hydroxide and carbon dioxide in the reservoir fluid to form sodium bicarbonate is an example of a reaction that would add to the weight of solids recoverable at the surface.

Table 4 shows that the effluent water contained only 5 ppm of the sulfate radical when the well was not being treated. Section H of Figures 9 to 16, inclusive, and Section E of Figure 17 show that the sulfate radical was present in the effluent water in much higher concentrations when chromates were being injected. It is possible that a trace of hydrogen sulfide known to be present in the flowing fluid was oxidized by injected chromates with the formation of sulfates. (Hydrogen sulfide in the gas in a concentration of 1 ppm would contain the quantity of sulfur required to provide a concentration of 500 ppm of sulfates in the effluent water.) In Figure 17, the close correlation between sulfate concentrations (Section E) and weights of chromate injected (Section I) suggest that such reaction also would add to the weight of solids recoverable from the effluent water.

Although chemical reactions in the flowstream may interfere with any accurate accounting of the weight of material recovered in the effluent water, and available methods may not permit accurate sampling of effluent water which contains solids in suspension and as a sediment, it is helpful to determine whether all the material injected into the well is returned to the surface by the flowing fluid. A computation of material balance, based on the analytical determination of total solids by evaporation, seemed to offer the most reliable means of accounting for the injected materials.

Another means of accounting for the materials injected into the well involved an analysis of the water from the well

for its reduced chromium content. The dashed curve drawn in Section G for May-August, 1946, shows the part of the total solids recovered in the effluent water, which by analysis was a compound of chromium in a reduced or trivalent form. In making the analysis, sodium peroxide was used to oxidize the material contained in a sample of water from the well, and the concentration of the soluble chromate resulting from the reaction was determined as sodium chromate ($Na_2CrO_4.4\,H_2O$). Errors involved in obtaining representative samples of the effluent water for determination of reduced chromates are of a more serious magnitude than those that affect determination of solids by evaporation because the insoluble reduced chromates are in the form of a suspension or a granular sediment which may be present in the water in copious quantities one day and almost entirely absent the next. A comparison of the quantities of reduced chromates recovered in the sample, as indicated by the dashed curve in Section G of Figure 17, with the quantities of chromates injected as shown in Section I indicates that, in general, not enough reduced chromate was recovered with each water sample.

Section F shows the material-balance ratio for materials entering and leaving the well in the liquid water phase. The "material-balance ratio," as the term is used in this report, is the ratio.

$$\frac{\text{Weight of material carried to the surface}}{\text{Weight of material injected into the casinghead}}$$

In Figure 17, Section F, these ratios are ratios at corresponding times of ordinate values of Section G to ordinate values of Section I. For those times when the weight of solids carried to the surface by the flowing water was equal to the weight of solids injected into the casinghead of the well, the value of the ratio is 1. The material-balance ratio is greater than 1 during those periods when solids were being removed from the tubing at a faster rate than they were injected into the well. At such times it would be expected that the flow capacity of the tubing would increase because it seems probable that the excess of solids must come from deposits that previously accumulated in the tubing. In Section F, areas under the curve for ratio values greater than 1 are cross-hatched so that the periods when solids were removed from the tubing faster than they were deposited can be more readily compared with those periods when measures of the flow rates show that the capacity of the tubing actually was increasing. Material-balance ratios shown in Section

TABLE 9

Consumption of chromates used in treating the well

1	2	3	4	5	6	7	8	9	10	11	12
	MATERIALS INJECTED PER MILLION CU. FT. OF GAS						EFFLUENT WATER				
TEST PERIOD, YEAR, MONTH AND DAY	Water, Gal.	Chromate Injected, Lb.	Chromate in Effluent Water, Lb.	Chromate Consumed, Lb.	Equivalent Sodium Chromate Lb.	Sodium Hydroxide, Lb.	pH	$Na_2CrO_4 \cdot 4H_2O$, p.p.m.	Iron, p.p.m.	Coupon Corrosion, i.p.y.	Change in Conductivity of Tubing, Percent per Day
TREATMENTS TENDING TO MAINTAIN OR IMPROVE FLOW CAPACITY OF TUBING											
A—Tests with Sodium Chromate and Sodium Hydroxide											
1946, 6-4 to 6-11	22.6	1.13	0.002	1.13	1.13	1.35	7.5	6	8	0.002	0.2 I
1946, 6-12 to 6-22	19.9	1.00	.002	1.00	1.00	1.79	7.7	4	7	.003	1.6 I.
1946, 6-23 to 7-2	19.7	.98	.005	.98	.98	2.36	7.9	11	3	.002	.1 D
1946, 7-19 to 7-25	24.2	1.22	.003	1.22	1.22	2.19	7.9	7	1	.002	.0
1946, 7-26 to 8-8	22.1	1.54	.076	1.46	1.46	1.99	7.7	170	1	.001	1.0 I
1946, 8-18 to 8-22	21.7	1.52	.110	1.41	1.41	1.95	7.6	250	1	.001	.7 D
Averages	21.7	1.23		1.20	1.20	1.94	7.7	75	4	0.002	0.3 I
B—Tests with Sodium Chromate											
1946, 11-15 to 12-6	36.0	1.80	0.089	1.71	1.71	0.00	7.2	170	0	0.000	0.0
1946, 12-8 to 12-17	40.3	1.41	.040	1.37	1.37	.00	6.9	72	2	.002	.2 D
Averages	38.2	1.60		1.54	1.54	0.00	7.0	121	1	0.001	0.1 D
TREATMENTS TENDING TO LOWER FLOW CAPACITY OF TUBING											
C—Tests with Sodium Chromate and Sodium Hydroxide											
1946, 5-2 to 5-20	12.0	1.20	0.008	1.19	1.19	0.20	7.4*	22	3	0.002	1.9 D
1946, 5-21 to 6-2	19.0	1.90	.358	1.54	1.54	.57	7.4	840	1	.001	2.9 D
1946, 7-3 to 7-18	22.8	1.14	.003	1.14	1.14	4.10	7.9	7	1	.003	1.1 D
1946, 8-9 to 8-17	21.5	1.50	.097	1.40	1.40	2.57	7.6	220	1	.000	3.1 D
1946, 10-26 to 11-13	26.0	1.82	.364	1.46	1.46	2.34	7.5	780*	0*	.000*	1.0 D
1947, 5-11 to 5-26	48.8	1.46	.221	1.24	1.24	1.95	7.5*	370	0	.005	.6 D
Averages	25.0	1.50		1.33	1.33	1.96	7.6	373	1	.002	1.8 D
D—Tests with Sodium Chromate											
1945, 10-28 to 11-13	7.4	2.21	0.194	2.02	2.02	0.00	7.1	540	4	0.001	1.0 D
1945, 12-4 to 12-19	5.9	1.77	.133	1.64	1.64	.00	7.4	380	2	.002	2.6 D
1946, 12-18 to 12-21	64.9	2.28	.263	2.02	2.02	.00	6.8	380	0	.....	.5 D
Averages	26.1	2.09		1.89	1.89	0.00	7.1	433	2	.001	1.4 D
E—Tests with Sodium Dichromate											
1947, 1-25 to 2-11	23.9	1.63	0.058	1.57[1]	1.71	0.00	6.2	70*	1*	0.005	1.0 D
1947, 2-13 to 3-7	27.9	2.79	.642	2.15	2.34	.00	6.4	730	0	.002	1.0 D
1947, 3-9 to 3-29	44.4	2.09	.061	2.03	2.21	.00	6.7	58	0	.002	.4 D
1947, 4-5 to 4-19	86.2	2.67	.345	2.32	2.52	.00	6.5	230*	0	.003	.9 D
Averages	45.6	2.30		2.02	2.20	0.00	6.4	272	0	0.003	0.8 D
F—Test with Chromic Acid											
1947, 4-24 to 5-10	55.1	1.65	0.006	1.64[2]	2.66	0.00	5.1	13	4*	0.005	0.4 D

[1] One pound of sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$) is equivalent to 1.087 lb. of sodium chromate (Na_2CrO_4).

[2] One pound of chromic acid (CrO_3) is equivalent to 1.62 lb. of sodium chromate (Na_2CrO_4).

* In these instances only the data for the last half of the test period were used in estimating the values that would obtain if the period were extended indefinitely

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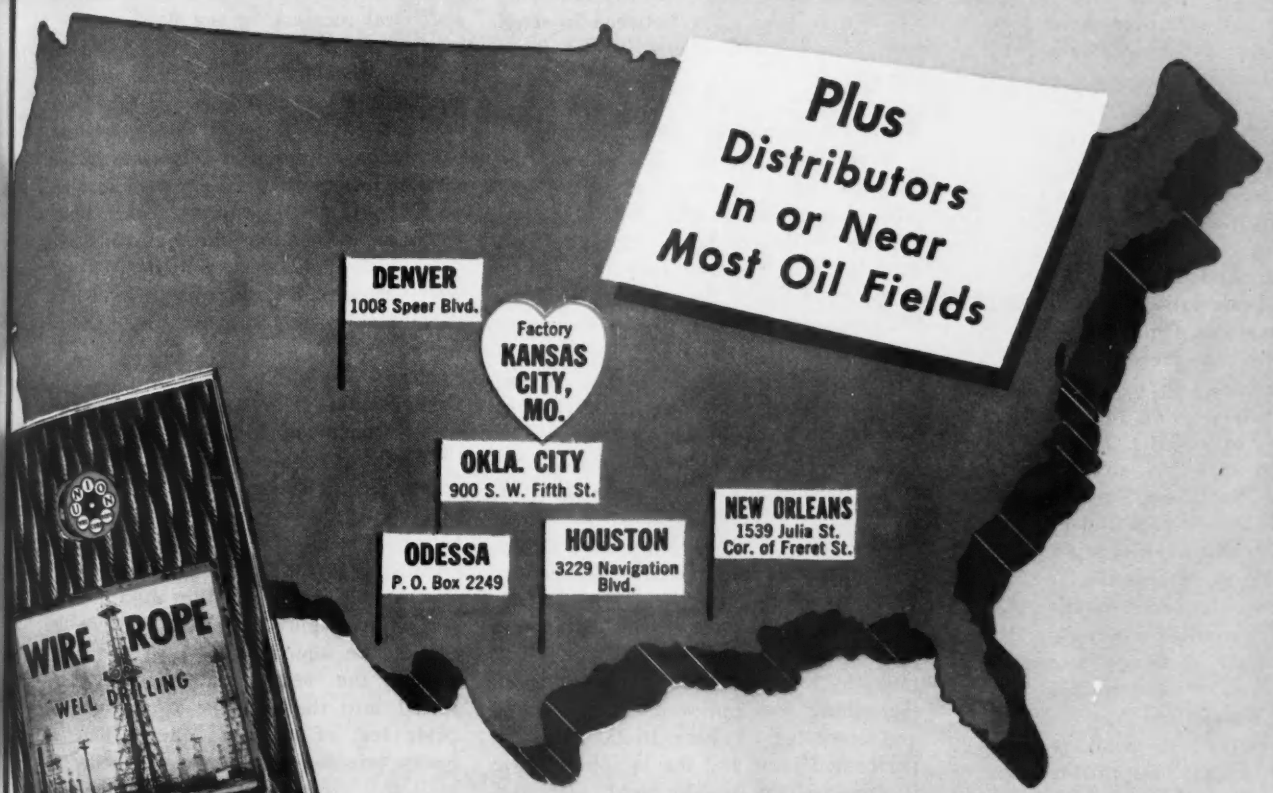

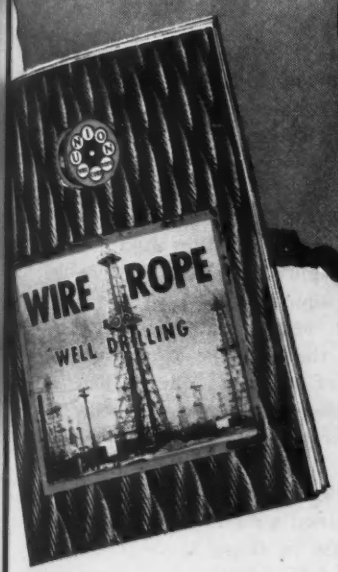

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F would be expected to be less than 1 when the flow capacity of the tubing was decreasing as the result of an injection treatment.

Section K of Figure 17 shows the rate of flow of gas from the test well, and Section L shows the corresponding flow capacity factor of the tubing. The data used in preparing Sections K and L are the same as were used in plotting Sections A and D, respectively, of Figures 9 to 16, inclusive. Trends in the two curves are similar, the principal difference being that over given periods the flow-capacity factor changes by a greater percentage than the rate of flow of gas.

During October, November, and part of December, 1945, when sodium chromate was being injected into the well in a quantity providing an excess in the effluent water, the flow capacity of the tubing decreased appreciably, and the material-balance ratio shown in Section F was less than 1 most of the time. Subsequently, when only water was injected into the well to wash accumulated deposits out of the tubing, the ratio greatly exceeded 1. Thus, for those times when the flow capacity of the tubing was decreasing, there was but little cross-hatched area under the curve of Section F, and when the flow capacity of the well was increasing, the cross-hatched area was predominant. A similar but less marked relation prevailed in the sodium chromate-injection and water-injection tests that followed in February, March, and April of 1946.

With reference to Sections I, J, K and L of Figure 17, maintenance of flow capacity of the tubing and control over corrosion were most satisfactorily obtained by the series of treatments using mixtures of sodium hydroxide and sodium chromate. The individual treatments within the series provided different results; but, for most of the tests, the material-balance ratio (Section F) was greater than 1. During June, July, August, and November, 1946, when these tests were in progress, cross-hatched areas predominated under the material-balance ratio curve.

From January through April and part of May, 1947, when sodium dichromate and then chromic acid were used in treating the well, the rate of flow of gas from the well and flow capacity of the tubing declined consistently. For this period, values of the material-balance ratio usually were considerably less than 1, indicating that the weight of reaction products and other solids in solution or in suspension in the flowstream at the tubinghead was less than the weight of treating material entering the tubing.

Material-balance ratios, as computed for Section F of Figure 17, are useful for determining in one observation whether deposits in a flowstring are being removed or are accumulating. The accuracy of the computed ratio, however, is limited by the accuracy with which a stream containing suspended matter can be sampled, by the accuracy of an analysis of the sample for content of substances in solution, and by the accuracy with which water:gas ratios may be estimated at flowstream pressures and temperatures. The accuracy also is affected by chemical reactions which may take place between injected material and components in the flowstream.

Location of Deposit in Tubing

Section M, Figure 17, shows the height above the bottom end of the 2½-inch tubing at which a cylindrical weight 1¾ inches in diameter came to rest when it was lowered into the tubing at different times. On January 2, 1946, the top of the deposit of reduced chromates was found to be at a point 101 feet above the lower end of the tubing; but on January 25, after a period of washing with water, the weight could be lowered to within 15 feet of the bottom of the tubing. As shown in Section M, similar measurements made on subsequent dates following the last water-wash treatment in March and April of 1946 showed that the height of the deposit was increasing. No measurements were made after April 3, 1947, at which time the height was 265 feet, but when the tubing was removed from the well and inspected on June 16-25, 1947, the perforated joint and the 18 joints above it (approximately 570 feet) were replaced because their inside walls were coated with a deposit of hydrous chromic oxide.

Sodium Chromate and Alkali Mixtures Increased Flow Capacity of Tubing

Although the tests at the well in the Cotton Valley field during the 20-month period were conducted with due concern for possible decrease in the flow capacity of the tubing, this consideration did not prevent the planning of tests which would provide information needed on the characteristics of the chromates. If the tests involving the injection of excessive amounts of sodium chromate per million cubic feet of flowing gas had not been made during the first eight months, and if the tests involving the injection of chromate solutions of relatively low pH had not been made during the first five months of 1947, the flow curves shown in Sections K and L of Figure 17 would not indicate a progressive decrease in the flow capacity of the well. The series of tests using mixtures of sodium chromate and sodium hydroxide made in the six-month period beginning in June, 1946, caused a general increase in the flow capacity of the tubing. The presence of a deposit on the walls of the tubing is of no serious consequence if it does not lower the flow capacity of the well to values below production requirements. Results of the tests indicated that if only the most favorable of the treatments using dilute solutions of sodium chromate and sodium hydroxide were practiced at the well, appreciable deposits of reduced chromates would not accumulate in the tubing.

Computation of Weight of Chromates Consumed in Flowstream

Insofar as possible, the field tests were conducted in a systematic manner to yield information on the controllable factors that affected the consumption of chromates in the flowstream of the well. The factors on which the most conclusive information was obtained were the pH of the aqueous phase in the flowstream, the weight of a chromate injected into the flowstream per million cubic feet of gas, and the volume of water injected into the well with the inhibitor. To facilitate an analysis of the test results, Table 9 has been compiled from data given in Table 7 to show results obtained with the different treating materials in those tests that were characterized by a surplus of chromates in the effluent water. As in Table 7, the tests are identified by the dates on which they were made. The test results obtained from August 23 to September 4, 1946, were omitted because only 0.39 pounds of sodium chromate per million cubic feet of gas was injected into the well. The trace of sodium chromate found in the effluent water while this 13-day test was in progress was not believed to indicate a condition that would

TABLE 10

Average of test results showing the relation between pH of the effluent water and consumption of the chromate used in treating the well

INJECTED MATERIALS	pH of Effluent Water	Equivalent Sodium Chromate Consumed, Lb. per Million Cu. Ft.	Change in Conductivity of Tubing, Percent per Day
Sodium chromate plus sodium hydroxide	7.7	1.20	0.3 I
Sodium chromate	7.0	1.54	.1 D
Sodium dichromate	6.4	2.20	.8 D
Chromic acid	5.1	2.66	.4 D

Note: Only the treatments providing a surplus of chromates in the effluent water and substantially complete corrosion control were considered in compiling the averages for this table.

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prevail indefinitely without increasing the rate of input of treating material. Each of the treatments listed in the table provided substantially complete corrosion control and when sodium chromate and sodium hydroxide were used, the tendency to maintain or increase the flow capacity of the tubing was indicated.

Certain data were included in Table 9 so that the computation of significant averages could be illustrated. The parts per million of chromates in the effluent water, as determined by analysis and the estimated volume of water flowing through the tubinghead per million cubic feet of gas, were used in computing the weight of a chromate in the effluent water (Column 4). The weight of a chromate injected (Column 3) less the weight of that molecular form of the chromate recovered in the effluent water provided the datum, "chromate consumed" (Column 5). For the purpose of comparing the results of tests when different chromates were used, the data on consumption of sodium dichromate and chromic acid were converted to equivalent weights of sodium chromate. The equations relating the different molecular forms of hexavalent chromium were discussed earlier in this report.

There appears to be no consistent relation between the weight of a chromate consumed per million cubic feet of gas produced by the well and the rate at which the gas was flowing. For the six tests with sodium chromate and sodium hydroxide listed in Section A of Table 9, average rates of flow varied from 3.3 to 4.8 million cubic feet of gas per day, and the length of time the chromate in solution was in contact with the flowing hydrocarbons seemed to have no bearing on the weight of sodium chromate consumed.

Consumption of Chromates Can Be Minimized by Maintaining High pH in Flowstream

Tests made with solutions of chromic acid, sodium dichromate, sodium chromate, and mixtures of sodium chromate and sodium hydroxide gave definite indications of the effect of pH on the rate of reduction of chromates in the flowstream. Averages compiled in Table 9 have been assembled in Table 10 to permit ready comparison of the pertinent test results. Data lines 1 to 4, Table 10, are taken from the averages of data in Sections A, B, E, and F respectively of Table 9.

For the treatments with the different materials, the average pH of the effluent water measured at atmospheric pressure ranged downward from 7.7 to 5.1. Corresponding to these values of pH, the quantities of the materials consumed ranged from 1.20 to 2.66 pounds of sodium chromate per million cubic feet of gas produced. Except for the treatments with sodium chromate and sodium hydroxide, the flow capacity of the tubing decreased at rates proportional to the weight of chromate consumed. Thus, the lower the pH, the greater the tendency for deposits to accumulate in the tubing. On the basis of the tests at the Cotton Valley well and supporting theoretical considerations, less chromate material will be required in treating a gas-condensate well and the flow capacity of the tubing will be better maintained if the pH of the effluent water is kept high by injecting sodium alkalies with the chromate. It was found that injecting 1.95 pounds of sodium hydroxide per million cubic feet of flowing gas with the sodium chromate increased the pH of the flowstream 0.7 of a unit; to increase the pH much more would have required the neutralization of an appreciable part of the more than one ton of carbon dioxide flowing with each million cubic feet of gas.

Consumption of Chromates Not Appreciably Affected by Volume of Water Injected

The test results which indicated that the consumption of a chromate could be minimized by injecting only enough of the inhibitor into the flowstream to provide a small surplus in the effluent water would seem to be subject to interpretation by a common law of physical chemistry. Expressed in simple terms, the rate of a chemical reactions is proportional to some function of the concentration of the reactants; or more specifically, the rate of chemical reduction of a chromate will be low if its concentration in solution is low. Another way of keeping the solution concentration low and minimizing chemical reduction would be by injecting water into the flowstream at high rates.

Table 11 was compiled from Table 9 to permit comparison of test results obtained when different volumes of water were injected into the well with sodium chromate and sodium dichromate. As it was impossible to select test results for each chromate for which the concentrations of chromates in the effluent water and the pH were the same, these data have been recorded in column 4 and 5 respectively so that quantities of chromates consumed (Column 3) can be weighted accordingly.

The tests with sodium chromate involved injecting water at volumetric rates ranging from 5.9 to 64.9 gallons per million cubic feet of gas. The weights of chromate consumed, as shown in Column 3, are not proportional to volumes of water injected and vary in a way suggesting that differences in their values were caused by experimental inaccuracies. Correction of the weights of sodium chromate consumed for differences due to variation in pH and concentrations in the effluent water could not be made accurately, but the results obtained did not indicate that the weight of sodium chromate consumed was affected by the volume of water injected.

The results of tests of sodium dichromate are believed to be subject to the same interpretation as the data obtained by injecting sodium chromate.

Without definite information on the kinetics of the reduction reaction and the nature of the involved reducing agents, speculation for the purpose of explaining the related effects of variation in rate of injection of chromates and water can lead to harmful as well as helpful conclusions. Although the results of eight tests have not shown that the consumption of chromates is affected by change in the rate of injection of water (change in concentration of the aqueous flowstream phase), the results of 17 tests to be discussed in the following section of this report show reliably that the rate of chromate injection should be just rapid enough to provide a small surplus of chromates in the effluent water from the well.

Deposits of reduced chromium com-

TABLE 11

Effect of injecting large volumes of water on consumption of chromates

1	2	3	4	5	6
Test Period, Year, Month and Day	Water Injected, Gal. per Million Cu. Ft. Gas	Chromate Consumed, Lb. Na_2CrO_4 per Million Cu. Ft. Gas	$Na_2CrO_4 \cdot 4H_2O$ in Effluent Water, p.p.m.	pH of Effluent Water	Change in Conductivity of Tubing, Percent per Day
Tests of Sodium Chromate					
1945, 12-4 to 12-19	5.9	1.64	380	7.4	2.6 D
1946, 11-15 to 12-6	36.0	1.71	170	7.2	.0
1946, 12-8 to 12-17	40.3	1.37	72	6.9	.2 D
1946, 12-18 to 12-21	64.9	2.02	380	6.8	.5 D
Tests of Sodium Dichromate					
1947, 1-25 to 2-11	23.9	1.71	70*	6.2	1.0 D
1947, 2-13 to 3-7	27.9	2.34	730	6.4	1.0 D
1947, 3-9 to 3-29	44.4	2.21	58	6.7	.4 D
1947, 4-5 to 4-19	86.2	2.52	230*	6.5	.9 D

Note: These treatments provided a surplus of chromates in the effluent water and substantially complete corrosion control.

* In these instances only the data for the last half of the test period were used in estimating the values that would obtain if the period were extended indefinitely.

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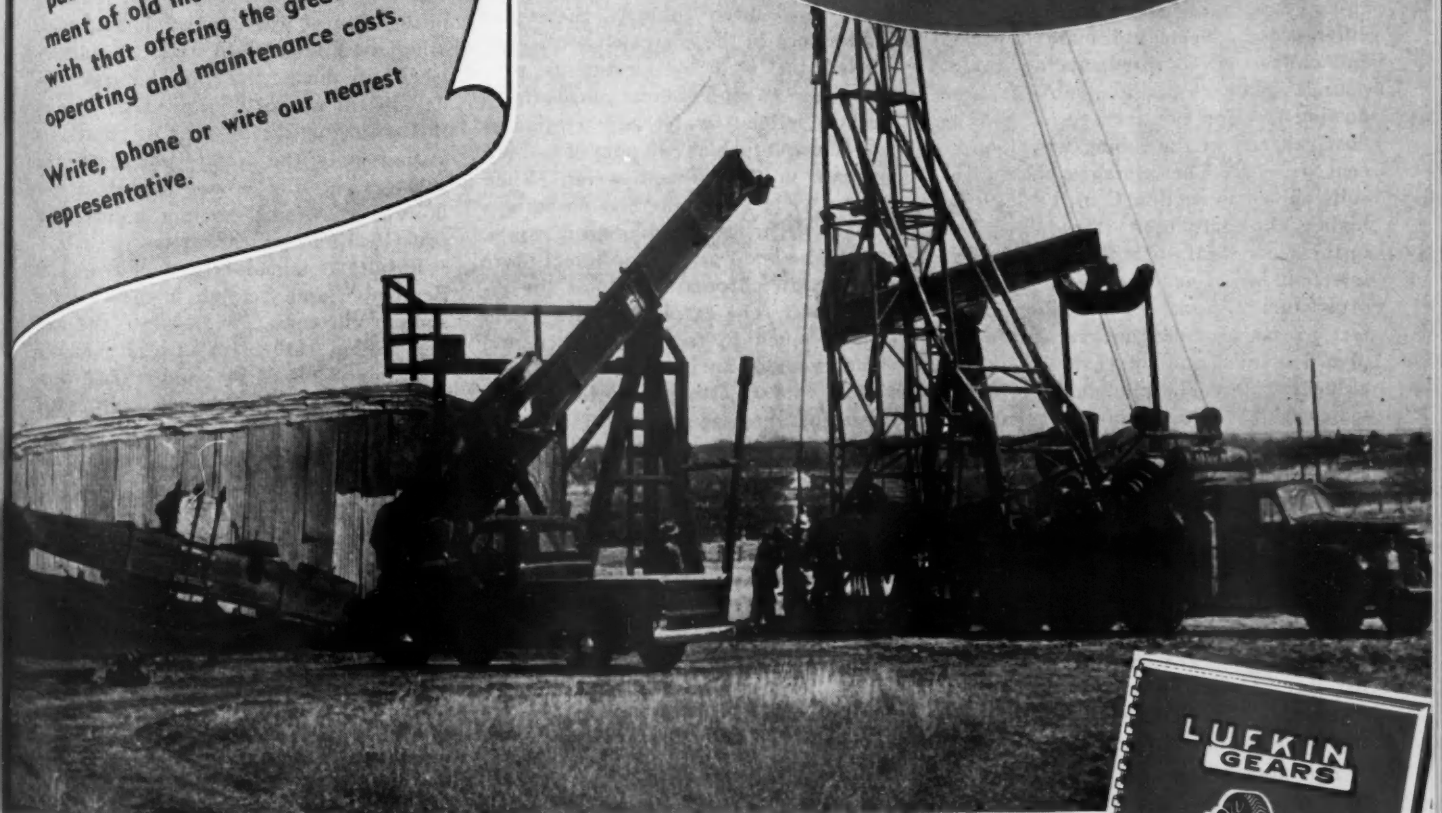

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pounds were the heaviest in the lowest joints of tubing. As more than enough water to saturate the fluid entering the well was injected with chromates during the tests, it may be that reduction of chromates in the aqueous medium begun immediately after the fluid entered the well bore. Not enough information was obtained on this point, however, to justify definite conclusions other than of the desirability of further study of the effect of variations in rate of water injection.

Consumption of Chromate Proportional to Concentration in Flowstream

The averages compiled in Table 9 have been used in Table 12 to demonstrate that the consumption of a chromate is proportional to its rate of input and hence its concentration in the flowstream. The results of six tests with sodium chromate and sodium hydroxide shown in Section A of Table 9 provided the average shown in the first data line in Table 12. The 1.23 pound average of sodium chromate injected per million cubic feet of gas provided an excess of chromates in the effluent water averaging 75 ppm Chromate consumed, the difference between chromate injected and chromate recovered, averaged 1.20 pounds for each million cubic feet of flowing gas and the average increase in flow capacity of the tubing was 0.3 percent per day. The averages of test results shown in section C of Table 9 for higher chromate-input rates are given in the second data line of Table 12. The injection of an average of 1.50 pounds of sodium chromate per million cubic feet of gas provided an average excess of 373 ppm of sodium chromate in the effluent water. The abundance of chromates in the effluent water was accompanied by an average consumption of 1.33 pounds per million cubic feet of gas as compared with 1.20 pounds when there was an average of only 75 ppm of excess chromates in the effluent water. Corresponding to the increased consumption figure, the flow capacity of the tubing decreased at the rate of 1.8 percent per day as compared to 0.3 percent per day increase when the treatments involved a lower concentration of chromates in the flowstream.

The averages in the third data line in Table 12 for two tests of sodium chromate were taken from Section B of Table 9. The fourth data line was taken from the averages of the results of three tests shown in Section D of Table 9. The results of these treatments, providing a pH of the effluent water averaging 7.0, indicate that the consumption of sodium chromate increases as the concentration of the chromate in the flowstream increases. The tests for which the concentration of sodium chromate in the effluent water averaged 433 ppm were accompanied by a decrease in the flow capacity of the tubing at the average rate of 1.4 percent per day as compared with a lowering in flow capacity at the rate of 0.1 percent per day when the average concentration of chromates in the effluent water was 121 ppm. It is indicated that the consumption of sodium chromate could have been lowered and the flow capacity of the well increased by using only enough sodium chromate in the flowstream to provide a chromate color in the effluent water.

Inspection of the results summarized in Table 9 of tests with sodium dichromate shows that consumption of the treating material was the lowest for the two of the four tests for which the concentration of chromates in the effluent water was the lowest. It is not definitely indicated, however, that the flow capacity of the tubing in the test well could be maintained by injecting only enough sodium dichromate to color the effluent water.

As indicated by the iron content of the effluent water and the rates of corrosion of wellhead coupons, there was no difference in the corrosion protection afforded the well by treatments providing only enough sodium chromate to color the effluent water and treatments providing as much as 840 ppm of sodium chromate in the effluent water. When treating wells where there is no serious problem of chromate reduction it would, perhaps, be good practice to inject more than enough chromate to color the effluent water. The extra chromate would not add much to treatment costs, and in the event of an increase in the production rate or stoppage of injecting equipment, the water in the flowstream would remain colored all the way up to the tubinghead for a longer time. For wells like the test well in the Cotton Valley field, however, the data averages in Table 12 show that it is desirable to maintain only enough sodium chromate in the effluent water to insure treatment of exposed metal surfaces in the tubinghead and christmas tree. An aqueous solution containing 50 ppm of sodium chromate has a definite yellow color which can be easily identified at the well and a colorimetric test[4], readily made in the laboratory, can be used to identify much lower concentrations.

Corrosion Control Provided by Dilute Solutions of Sodium Chromate

As previously discussed in connection with Table 12, tests in the Cotton Valley field showed that the difference between the weight of chromate injected and that recovered in the effluent water decreased as the weight of the chromate injected was decreased. Although it is recommended that injection operations be conducted in such manner that a sample of water withdrawn from the tubinghead have only the faint yellow color indicating a slight surplus of chromate, it is important to consider how corrosion control will be affected in the upper part of the flowstring and christmas tree fittings if there are no surplus chromates in the effluent water at times. A pump adjusted to inject into a well only that quantity of chromates necessary to provide 50 ppm more or less, of inhibitor in the effluent water under normal operating conditions might inject at a diminished rate during the colder hours of the day, or the rate of fluid production from the well might increase so that, for a time only the water which covered surfaces in the lower parts of the flowstring would contain appreciable concentrations of chromates.

Results obtained at the test well in September and October, 1946, when the sodium chromate injected into the well per million cubic feet of gas averaged 0.32 pounds — 1.54 pounds had been found necessary to provide chromates in the water all the way to the surface —indicated that serious corrosion would develop at the wellhead only after ten days or more of injecting insufficient quantities of the inhibitor. Figure 12 shows that, over a period of 38 days, the rates of corrosion of coupons exposed at the wellhead increased gradually from 0.0024 ipy to 0.072 ipy as

TABLE 12

Relation between consumption of chromates and concentration in the flowstream and effluent water

Number of Tests Averaged	Chromate Injected, Lb. per MMCF	Chromates in Effluent Water, p.p.m.	Chromate Consumed, Lb. per MMCF	Change in Conductivity of Tubing, Percent per Day
Tests with Sodium Chromate and Sodium Hydroxide[1]				
6	1.23	75	1.20	0.3 I
6	1.50	373	1.33	1.8 D
Tests with Sodium Chromate				
2	1.60	121	1.54	0.1 I
3	2.09	433	1.89	1.4 I

[1] The average amount of sodium hydroxide injected was 1.95 lb. per million cu. ft. of flowing gas.

Note: For all the tests considered a surplus of chromates was present in the effluent water.

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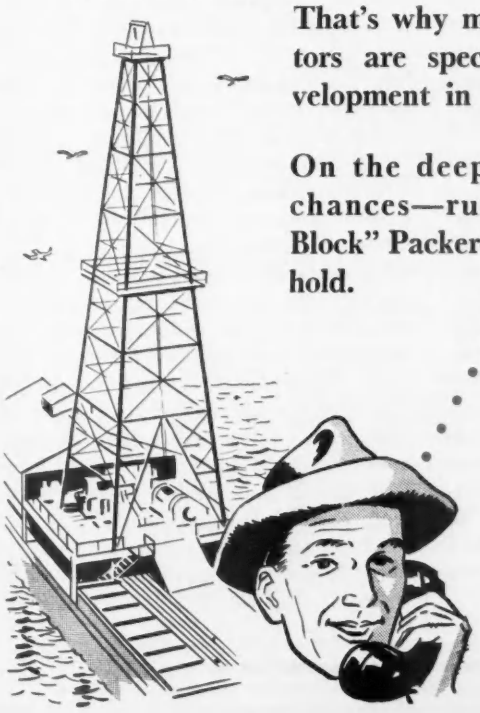

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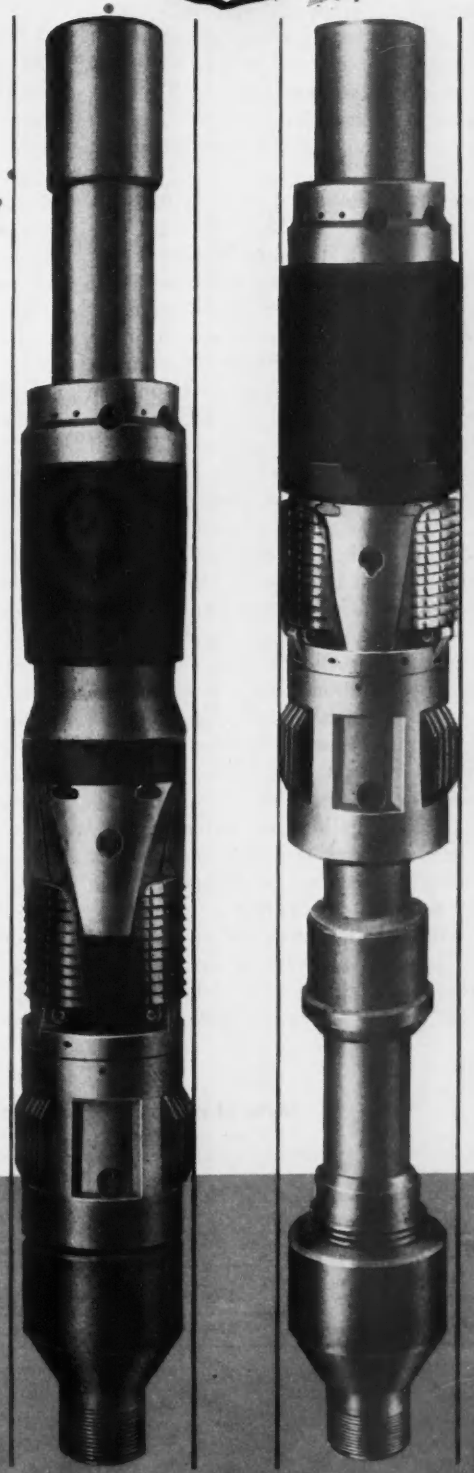

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compared with 0.045 ipy before injection tests were made at the well. At the same time the concentration of iron in the effluent water increased from 2 ppm to 6 ppm as compared with 100 ppm before the tests were made and 46 ppm seven weeks after the injection of chromates had ceased.

The injection rate maintained during this 38-day period provided an extreme test of the corrosion risk that prevails when the quantity of sodium chromate injected is inadequate to maintain flowstream concentrations all the way to the surface. No sodium chromate was found in the effluent water at any time and yet the rate of corrosion of wellhead coupons increased very slowly. The rate equalled the rate of corrosion in the complete absence of inhibitor treatment only after 24 days.

The results of tests being made at a well of Humble Oil & Refining Company in the Katy field indicate that chromates injected into some wells at relatively low rates can be effective for corrosion control. The injection of an aqueous solution of sodium dichromate into two gas-condensate wells in the Katy field was started in March, 1947, and was continued until the middle of August, 1947, at an average rate of 0.4 pound per million cubic feet of gas for one well and 0.2 pound per million cubic feet for the other. The injection of the inhibitor was interrupted for a few weeks and then was resumed at an average rate of 0.1 pound per million cubic feet of gas for the first well and 0.07 pound per million cubic feet for the second well for the period September, 1947, through June, 1948. The tubing of each well was set on a packer and perforated for chemical injection. A maximum of ten gallons of water per day was used to carry the dichromate down the annulus between tubing and casing to the point of perforation.

Results of the analyses of wellhead water samples showed an average iron content for each well of about 3 ppm, for the period beginning soon after the start of injection in March 1947, through June 1948; a few values of about 100 ppm were obtained on samples which were taken at times when tubing caliper surveys were made in the wells. The chromate content of the produced water from each well fluctuated between zero and about 1600 ppm during the period of injection; the average value was approximately 200 ppm for each well. The results of tubing caliper corrosion surveys made in May, 1948, indicated that the tubing of each well was in good condition.

Judged by a comparison of the weight of dichromate injected and the weight returned to the surface in the effluent water from the wells, reduction of chromates in the flowstream of these wells in the Katy field was negligible. Concentration of the inhibitor in the aqueous phase of the flowstream was lowered only as the volume of water at different levels in the tubing was increased by condensation.

The possibility of loss of corrosion control when chromate solutions become low in concentration also has been investigated in the laboratory. Table 13 shows the rates of corrosion of H-40 and N-80 API grade tubing steel in propionic and carbonic acid mediums inhibited with sodium chromate in low concentrations. Sodium chloride was added to some of the mediums as indicated because, as shown by Darrin,[30] this salt can increase the rate of consumption of the chromates and is a significant factor in treating some gas-condensate wells for that reason. Both H-40 and N-80 API grade steels were used for test coupons because, unfortunately, not enough of either of these steels alone was available to make the number of coupons required.. As shown in Table 13, coupons of H-40 steel were tested in mediums of propionic and carbonic acids with and without sodium chloride to provide comparable measures of rates of corrosion needed to facilitate interpretation of the other data obtained by using two metals. The two metals are very similar in susceptibility to corrosion as indicated by data in a published report (31; p. 129) of the relative corrosion resistance of these metals. Moreover, the most important comparisons of the data are to be made vertically within the columns of the table and do not involve comparisons between the columns of test results obtained using different metals.

The general technique of the corrosion tests conducted at a temperature of 130° F. has been described in a former publication[31], and only minor modifications were made in the procedures to accommodate these special tests. The coupons averaged 0.25 square decimeter in surface area, and, as they were submerged in only 400 cubic centimeters of the solutions, much or all of the dissolved sodium chromate was consumed (possibly reduced to hydrous chromic oxide) in less than seven days. Accordingly, the solutions containing sodium chloride were renewed twice weekly and the others once each week. Operating in this manner, the solutions originally containing 40 ppm of sodium chromate usually retained some color on the seventh day. At the end of four days, the intensity of the yellow color of solutions containing sodium chloride and 40 ppm of sodium chromate diminished considerably, and traces of the inhibitor were found occasionally in solutions originally containing 20 ppm of sodium chromate. Solutions originally containing 10 ppm and 5 ppm of sodium chromate probably were not inhibited for more than a day.

The data in columns 3 and 4 of Table 13 for rate of corrosion in propionic acid indicate that sodium chromate in an initial concentration of 40 ppm provided substantial corrosion control. There was a general increase in corrosion rate with decreasing chromate concentrations, but rates of corrosion that might conceivably have resulted from a lack of sodium chromate, when used in an initial concentration of 5 ppm, do not differ significantly from the

TABLE 13

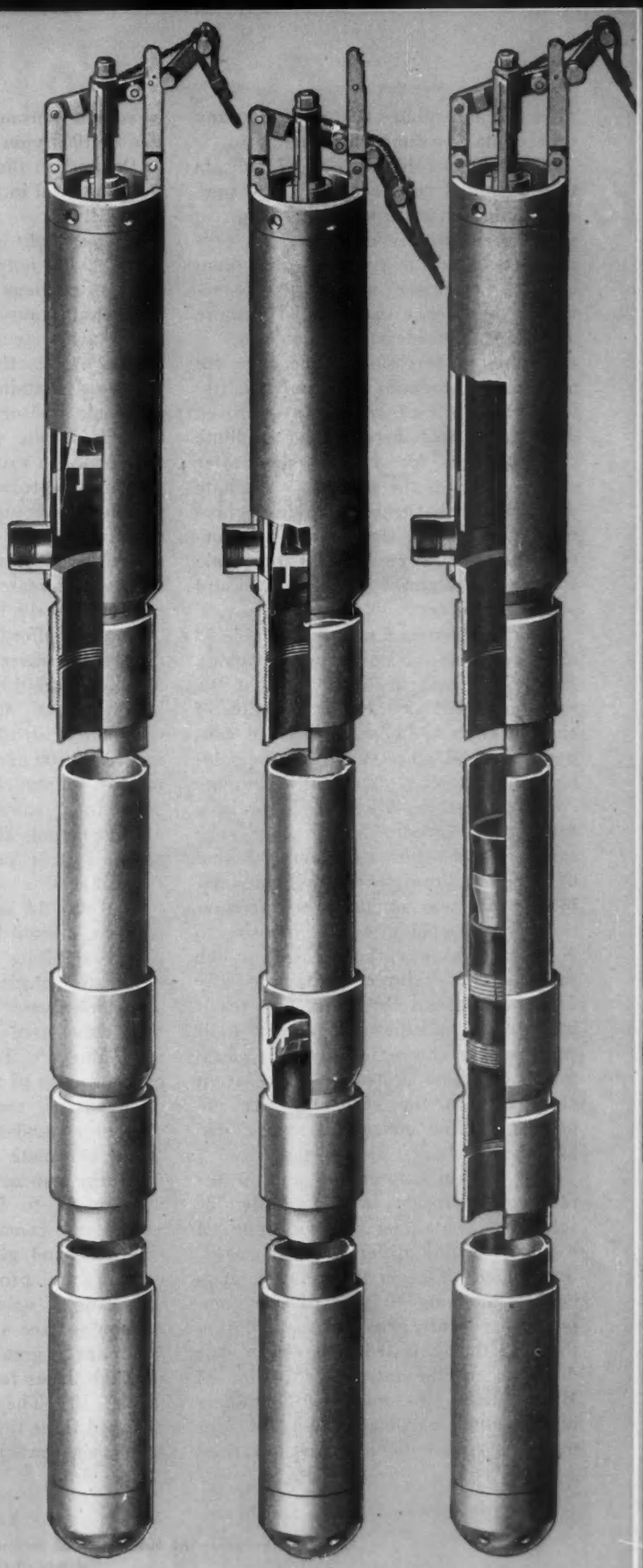
Rate of corrosion of tubing steel when provided only intermittent inhibitor protection by dilute chromate solutions

1	2	3	4	5	6	7	8	9	10	11	12	13	14
MATERIALS ADDED TO CORROSIVE MEDIUMS, p.p.m.		AVERAGE RATE OF CORROSION DURING INDICATED PERIOD OF EXPOSURE, m.d.d.											
		Propionic Acid						Carbonic Acid					
		N-80 Coupons, without NaCl			H-40 Coupons, with NaCl (10,000 p.p.m.)			N-80 Coupons, without NaCl			H-40 Coupons, with NaCl (10,000 p.p.m.)		
$Na_2Cr_4 \cdot 4H_2O$	$NaHCO_3$	7 Days	28 Days	70 Days	7 Days	28 Days	70 Days	7 Days	28 Days	70 Days	7 Days	28 Days	70 Days
40	0	8	2.6	...	91	69	...	170	0.79	59	240	300	...
20	0	93	35	...	97	69	...	380	90	47	430	330	...
10	0	76	37	59	74	86	...	380	158	37	340	350	...
5	0	118	80	...	91	65	...	380	141	38	340	350	...
0	0	105	85	...	86	83	...	520	171	...	330	340	...
0	0	90[1]	92[1]	...	...	...	...	330[1]	240[1]	...	...	...	...
5	100	...	...	...	...	...	...	420	147	19.1	...	...	...
5	1,000	...	...	...	...	...	...	350	84	22	330	220	...

[1] Coupons of H-40 API specifications steel.

Note: Surface area of coupon was 0.35 sq. dm., volume of solution was 400 cc.

BROWN METHOD OF CEMENTING CASING



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Permits release of cementing plug without stopping the pumps. Carrier sleeve supporting the plug allows full line pressure in the head to equalize on both ends of plug and relieves tripping mechanism of unbalanced forces. Release of carrier sleeve, which travels only a short distance in the head, diverts full pressure to the top of the plug, forcing it down with the top of the cement column. Increased pressure in casing string after plug has been released, returns carrier sleeve to top of head, giving indication the plug is being pumped to bottom.

3 NEW TYPE PLUG

Equipped with hold down slips, the plug provides a back pressure valve whenever and wherever needed, eliminating necessity of maintaining pressure on casing string after plug has stopped. When stopped in the landing collar, located desired distance off bottom in the casing string, the hold down slips make it impossible for the back pressure of the cement column to force the plug upward in the casing string. The plug is made entirely of drillable material.

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rates in the mediums that did not at any time contain sodium chromate.

The data in columns 6 and 7 indicate that an initial concentration of 40 ppm of sodium chromate was not enough to provide control of corrosion by propionic acid in the presence of sodium chloride when the solutions were renewed only twice each week. A more important consideration, however, is that rates of corrosion in the complete absence of chromates differ only slightly from the rates of corrosion measured when chromates were present in dilute concentrations for a short time after each renewal of the solutions. The data do not show that traces of sodium chromate can increase significantly the corrosiveness of a medium of propionic acid or a medium of propionic acid and sodium chloride.

Data in columns 9 and 10 of Table 13 showing rates of corrosion of tubing steel in carbonic acid indicate that the rates increased as the concentration of chromates decreased, and that all coupons of N-80 steel suspended in solutions containing sodium chromate corroded less rapidly than those in a solution of carbon dioxide only. The carbonic acid solution containing 5 ppm of sodium chromate to which sodium bicarbonate was added in a concentration of 1000 ppm was less corrosive to N-80 steel than carbonic acid or the carbonic acid solution containing only 5 ppm of sodium chromate. This result indicates that alkalies injected into wells with sodium chromate provide a measure of corrosion protection in the event chromates in the effluent water are present in low concentrations or disappear entirely.

The data in columns 12 and 13 for rates of corrosion in carbon dioxide solutions containing 10,000 ppm of sodium chloride differ only slightly. Sodium chromate in the solution originally containing 40 ppm of this compound apparently was of benefit during the time that it lasted. There was little difference in the rates of corrosion of H-40 steel in the mediums containing no sodium chromate and in the mediums containing low concentrations of sodium chromate initially. The addition of 1000 ppm of sodium bicarbonate to the carbon dioxide test medium was less beneficial in the presence of sodium chloride.

On a weight-loss basis, the data of Table 13 do not show that dilute solutions of sodium chromate diminishing in strength cause tubing steels exposed in them to corrode at significantly greater rates than would prevail in mediums containing at all times only propionic acid or carbonic acid. Sodium chloride in the solutions may increase the corrosion rates of steels only intermittently protected by sodium chromate in dilute concentrations, but under no condition was it found that dilute fluctuating concentrations of chromates seriously increased the rate of corrosion of tubing steels. In general, the corrosion protection afforded by the chromates simply decreases as the concentration of the inhibitor solutions decrease below about 40 ppm. Substantially complete corrosion protection is afforded by 300 ppm or greater concentrations of sodium chromate in the presence of sodium chloride in concentrations ranging from 200 to 20,000 ppm as reported in a previous publication (1, Table 2).

In Table 14 are reported the results of tests designed to measure the corrosion-inhibiting capacity of dilute chromate solutions the concentrations of which were more nearly constant than those used in developing the data for Table 13. To minimize change in concentration of the solutions with time of exposure, each coupon was made one-tenth standard size and the volume of the chromate solutions used was ten times the standard volume. Lucite tubes were made to fit inside the pressure vessels to contain the carbonic acid solutions, and glass jugs were used to contain the propionic acid solutions. The ratio of volume of test medium to coupon surface area was approximately 100 times as great for the tests indicated in Table 14 as for the tests indicated in Table 13. The test mediums were changed three times each week to maintain concentrations of contained sodium chromate ($Na_2CrO_4 \cdot 4H_2O$) as constant as possible. The data in columns 1 and 2 of Table 14 show the maximum variation in chromate content of the solutions that occurred during the tests.

The data of Table 14 are averages obtained by exposing coupons of API grade H-40 steel in the indicated test mediums for four seven-day test periods and for two 28-day test periods. They show without exception that the amount of protection afforded the steel by dilute chromate solutions is proportional to the concentration of inhibitor in the solutions. According to all the tests, the coupons in the solutions which contained no sodium chromate corroded at the highest rates; the presence in solution of as little as 4 to 10 ppm of sodium chromate reduced slightly the rates of corrosion in propionic acid and reduced to a considerable extent the rates of corrosion in carbonic acid. The data available show that differences in concentration of sodium chloride had little effect on rates of corrosion in otherwise similar mediums.

The relative amounts of localized corrosion of coupons used in obtaining the laboratory test results reported in Tables 13 and 14 were difficult to evaluate. The steels used are very susceptible to corrosion by carbonic and propionic acid so that all coupons were considerably altered in surface appearance. The corrosion of test coupons usually is greatest in the areas of the drilled hole and the identifying mark made with a steel stencil, and it is believed that the small coupons (0.034 square decimeter in surface area) corroded at such high rates because so large a fraction of the total surface was strained in the forming and marking operations. In general, the coupons showing the greatest weight losses were also the ones most changed in appearance.

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TABLE 14

Rate of corrosion of tubing steel when provided continuous inhibitor protection by dilute chromate solutions

1	2	3	4	5	6	7	8	9	10	11	12	13	14
SODIUM CHROMATE IN MEDIUMS, p.p.m.		AVERAGE RATE OF CORROSION DURING INDICATED PERIOD OF EXPOSURE, m.d.d.											
		Propionic Acid						Carbonic Acid					
		Without NaCl		NaCl (1,000 p.p.m.)		NaCl (10,000 p.p.m.)		Without NaCl		NaCl (1,000 p.p.m.)		NaCl (10,000 p.p.m.)	
As Prepared	After 3 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days
40	26	51	...	84	89	121	110	32	...	80	96	95	200
20	13	76	...	116	104	155	119	...	...	123	192	...	...
10	4	112	...	169	118	180	151	133	...	850	360	...	...
0	0	240	119	270	129	220	162	1,220	770	1,570	590	1,700	660

Note: Surface area of coupon was 0.034 sq. dm., volume of solution, was 4,000 cc.

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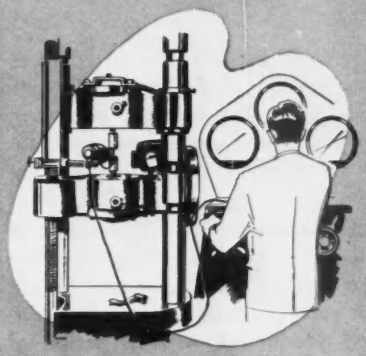

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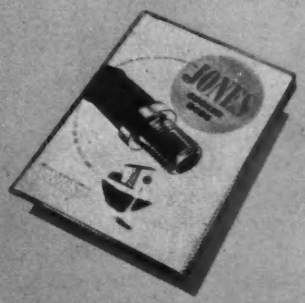

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Laboratory Water Drives

In Oil Sands

By HARRY M. RYDER

SIMULATION OF field conditions in laboratory tests to determine probable effects of water drives in oil sands presents many complications. None of these factors can be dismissed as irrelevant, as definite proof of relative importance is lacking.

TO DETERMINE the most effective procedure for water-flooding an oil sand, a knowledge of the findings of appropriate water drives made in the laboratory is necessary along with other information.

In the operation of an oil property the objective of a producer may be the greatest ultimate profit; it may be the greatest early income; the greatest ultimate oil production; a long period of steady income or oil production; a minimum of complications. There may be another objective. There may be a combination of two or more of these. For that operation, the "most effective" operation is that which will most effectively realize the chosen objective. The term "most effective" therefore has different meanings for different operators. It is used here in that multiple sense.

The most effective production of oil from a given property can be realized knowingly only by operating in accordance with the specific conditions necessary for such production. To be able to specify those conditions, it is necessary to know:

1. General development and operating costs for various modes of operation.
2. The probable market price of crude.
3. The capabilities of the available personnel and facilities.
4. The pertinent technical facts of the sand and contained fluids.
5. The effect on oil production (rate and quantity) of varying the application of the measures under the control of the operator.

The first three are not concerned with the nature of the sand and its contents. The fourth sometimes involves a knowledge of structural and other geology and always involves competent coring and testing.

Knowledge of the fifth of these is obtained at times in part from previous operating experience in similar sand. But to be adequate, that knowledge must be built on facts which must be obtained in the laboratory, for only in the laboratory can the necessary factors be sufficiently controlled and measured.

Referring specifically to the production of oil by water flooding, this means that a water-drive setup in the laboratory is necessary. In competent work of this nature the results are directly applicable only to the conditions obtaining during the course of that drive. But if sufficient data are available results may be competently predicted for some other specific circumstances.

If the results are to be competently translated to field conditions, the laboratory setup must completely simulate field conditions, simulation of certain aspects must be known to be unnecessary, or competent corrections must be applied to convert from laboratory conditions to the field circumstances.

This requirement does not invalidate the large number of laboratory water drives not closely simulating field conditions which have been undertaken. Much work under idealized circumstances is essential to the gaining of a knowledge of the mechanism of the water drive and the relation between various factors involved. But the direct application to field operation of the results of non-simulating water drives obviously must be done, if at all, with great caution. It must be emphasized that to justifiably translate laboratory water-drive findings to field conditions, the degree of simulation (or correction) must be known to be adequate.

To competently simulate field conditions, it is necessary to know these conditions; a list of the conditions requiring simulation must be prepared. That list can be prepared only from a broad, critical knowledge of the field and the actual behavior of water drives. Such knowledge does not come easily. It is acquired through the statistical study of many field measurements on the sand itself and on water drives progressing through that sand.

An oil-bearing, permeable sand is an exceedingly complex system — complex not only because of the intricate network of microscopic passages through it, but especially because of the large number of factors involved, and their diversity.

In an ordinary oil sand from which oil is being removed by means of a water drive, natural or artificial, some or all of the following independent factors are present:

1. Effective porosity.
2. Absolute permeability.
3. Pore-shape character.
4. Oil saturation.
5. Connate water saturation.
6. Encroachment or secondary water saturation.
7. Composition of pore surfaces.
8. Oil viscosity.
9. Fluid arrangements within the pores.
10. Macroscopic fluid arrangement.
11. Pressure in sand.
12. Pressure gradient.
13. Oil surface tension.
14. Light ends and polar compound content of oil.
15. The dynamics of swelling clay and more.

In addition to this there are dependent factors, among which may be listed:

1. Gas saturation.
2. Velocity of the drive.
3. Solubility of the oil in water at the pressure of the system.
4. Relative permeability of the sand to oil in those parts of the sand through which oil is moving.
5. Relative permeability of the sand to water in those parts of the sand through which water is moving.
6. Interfacial characteristics.

The problem of complete simulation of field conditions in the laboratory is obviously a complicated one. But if complete simulation is not realized, competent workmanship requires either proof that the lack of simulation is immaterial or the application of proper correction factors (probably experimentally determined).

As if this were not enough, there are other complications. End effects resulting in the abnormal "piling up" of one fluid at the discharge end of the sand have been discussed by Leverett, Yuster and others. Until such time as it is proved that end effects are immaterial, it would seem unwise to ignore them.

Again, an incorrect assumption of the means by which the motion of the water is transferred to the oil may lead to erroneous conclusions. Water pushes or

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drags[1] oil or carries it in solution.[2] Possibly all three means function simultaneously to some degree. In all water drives in the field, water only is forced into the sand. The means of transferring motion to the oil is controlled entirely by the physical nature of the system. No proof of the dominant means has been published. In some important laboratory work, water and oil or gas (in some cases all three) have been simultaneously forced into the sand. The parallel movement of all introduced fluids is thereby enforced. Some of this work has produced very valuable results. But field conditions are not simulated. However greatly such work adds to the knowledge of fluid movements, it would be unwise to deduce similar performance in the field where only one fluid is added to the sand.

Oil and water may move through a single pore at a single point. Or they may move in alternating slugs or in separate pores. These mechanisms are very different and no proof of a dominant one has been published.

Until more is known of the effects of these and other aspects, it is essential that every effort at complete simulation be made in the laboratory water drive if the results obtained are to be translated completely to field operation. This can be done with a degree of accuracy sufficient for the purpose. The economic aspects of the matter are so very important and the need for the greatest effectiveness in water-drive operations is so pressing that laboratory water drives adequately simulating field conditions should be undertaken without delay. The successful accomplishment of this work should aid greatly in planning for increasing oil recovery from favorable reservoirs; in many instances an important reduction in costs per barrel of oil produced should result. It should prove invaluable in determining in advance of production the production possibilities and costs for any specified property. It should save time and money now lost in attempting water drives in unfavorable areas.

The following discussion on a laboratory water drive simulating field conditions is intended only as a starting point. As laboratory work progresses, refinements will be found necessary. Collateral investigations will suggest themselves and will be important in the development of the actual water-drive setup and operation.

Capillary phenomena are very sensitive to pore shapes and sizes. As a first approach, natural sandstone should be used. It should be taken from a horizon geologically, mineralogically and physically equivalent to one in which water-drive production has been successful. Further, the porosity and permeability of the sand used should be within the range of successful field operation. The sand should, of course, be as uniform, geologically and physically, as practicable throughout the test piece. Other material, natural or synthetic, might be just as satisfactory, might even be preferable, but until proved suitable such substitution must be avoided when simulation is attempted. Sandstone meeting these specifications is available.

The test piece should be in the form of a long cylinder—preferably at least four feet long. The diameter should be at least two inches, but not over five inches. Because high mean pressure will be required (as discussed later), the test piece must be mounted within a strong steel tube, sealed in such manner that no fluid can move except through the test piece. Numerous facilities must be provided along the test piece for the purpose of making pressure measurements and possibly for fluid sampling. In this manner, pressure gradients from point to point can be determined, irregularities and pressure discontinuities can be located and measured and any end effect present can be eliminated. The sealing of the test piece must be so arranged that the sand can be removed from the tube without disturbing the fluid contents. This provides for later examination and verification of the results of the water drive.

Fluid Contents

The oil, water (or brine) and gas in the test piece at the start of a water drive must be chemically and physically essentially identical with the fluids found in a floodable oil sand. No evidence has been published which shows that, for simulation purposes, a close-cut petroleum fraction of proper viscosity will produce results equivalent to an unoxidized, unreduced crude oil. These two types of oil are fundamentally different. Unlike close-cut fractions, crudes contain polar compounds which may profoundly affect the attraction between the oil and the pore surfaces. Also, most crudes contain light ends which at high pressure are soluble in water.[2] The effect of such solubility at high pressure on interfacial tension is at present unknown. The quantitative effect of both polar compounds and that solubility on the quantity of oil removed from an oil-wet sand is not known. At the present time, to ignore either is to risk invalidation of the entire work due to lack of simulation.

The positions of the various fluids within the pores at the start of the water drive is equally important. Evidence has been presented[3] supporting the viewpoint that some sands are water-wet and others are predominantly oil-wet. The evidence suggests that the reaction of one type to a water drive is fundamentally different from that of the other type. The positions of the fluids within the pores is just as important as their quantities.

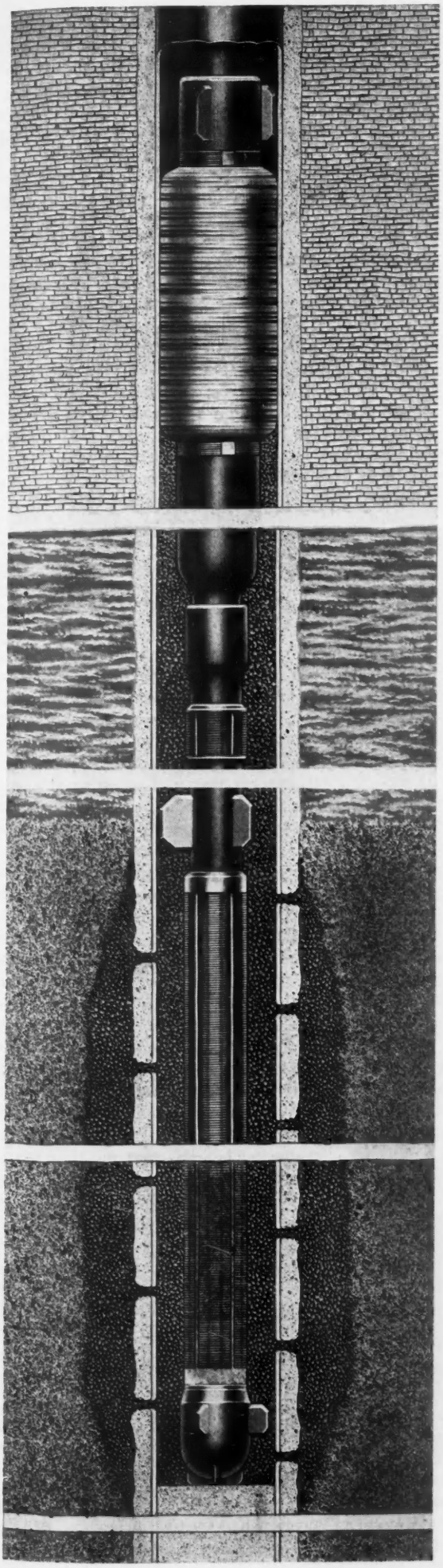
By proper procedure the fluids can be placed in any desired positions and in any desired quantities within the pores of the test piece. Oil can be placed in physical contact with the sand solids, or insulated from them at will. Since the positions of the fluids within the pores of an oil sand in place are not absolutely known, but only deduced, simulation in this regard cannot be absolutely certain. The several possible arrangements must therefore be experimented with and the facts ascertained. In deducing the positions from the probable history of the sand, the possibility of a gas movement through some sands prior to the entry of oil must not be ignored.

The chemical nature of the effective pore surfaces may have an important bearing on the effectiveness of a water drive. It has been shown[3] that in certain sands the exposed pore surfaces are composed of essentially solid organic material. In other sands, the pore surfaces are inorganic. The behavior under water-flood conditions of these two types may be very different. In an attempt to simulate field conditions, in some laboratories unextracted sand cores have been used. If the oil in such cores has never been exposed to oxidation or evaporation, if no change has occurred in the quantity of each fluid present and if all of the other conditions discussed above have been met, the use of unextracted cores is very desirable. Otherwise, the development of the proper surfaces on the pores must be accomplished in the laboratory. This, too, can be done.

Pressure and Pressure Gradients

So far, the discussion of simulation has concerned itself with the preparation of the test piece. The simulation of operating circumstances is no less important. Assuming the use of clean and otherwise suitable water or brine, the operator of water-drive oil production at the present time has basic control over only two factors: pressure and pressure gradient. True, he exercises that control through various devices (shooting, well spacing, pattern, etc.) in addition to his wellhead pressures. But his efforts are directed at developing pressure and pressure gradients at and through each sand element.

Pressure in the formation, as distinct from pressure gradient, may affect the quantity of oil produced from a given reservoir. It may enable fluids to move through pores otherwise blocked by size, gas bubbles, or liquid slugs. It is known that at high pressure light ends of crude oil are readily soluble in water.[2] This may affect oil production in at least two ways. An effect on interfacial tension might affect the quantity of oil removed



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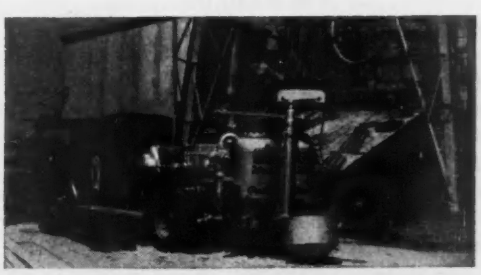

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from a pore. Most of the dissolved fractions will come out of solution (usually in or near a producing well) as the pressure is relieved, thereby affecting the gravity as well as the quantity of oil produced and of that remaining in the sand. The laboratory water drive intended to simulate field experience must therefore be conducted at elevated pressure. In the Bradford field this pressure is of the order of 1500 pounds per square inch. In the natural water drive in the East Texas Woodbine sand it is of the same order. In eastern Kansas it is mostly under 1000 psi.

It would seem obvious that pressure gradients and the resulting fluid velocities in simulated drives should range between the minimum and maximum experienced and practicably attainable in the field. The speeding up of laboratory water drives as a time-saving device may invalidate the results.

Measurements

Accurate knowledge of the quantity of each kind of fluid and of the arrangement within the pores at the start of a run is obviously essential and can be obtained or deduced. Knowledge of the fluid contents at various parts of the test piece throughout the duration of the run would be desirable and useful. Material balance and weight methods can provide information on average conditions, but not at specific points. If the primary objective is to determine the effectiveness of a water drive under the specific conditions, interim-content measurements are not essential. But accurate measurements at the end of the run are essential.

For this purpose accurate measurements of the fluids entering and leaving the test piece are essential. Since some of the oil leaving the test piece does so in liquid form, some in gaseous form and some in solution in the water, it is necessary to provide means for the accurate measurement of all three forms, including the specific gravities of the liquid oil and analysis of the gas. This can be done, but it is not sufficient. Upon completion of a run, the pressure in the test piece will be gradually reduced to atmospheric pressure. The separately measured effluent during pressure reduction is necessary in arriving at the fluid contents just prior to pressure reduction. The need is obvious for measurements leading to the determination of effective and relative permeabilities throughout the duration of the test.

Following pressure reduction the measurement of the fluid contents in various parts of the test piece is important. This can be done only by removing the test piece from the holder, breaking it into the desired pieces and running analyses for contents as desired. An extraction method, rather than combustion, should be used. Yuster has shown that water-content determination by a resistance method is unreliable. At this time permeability and porosity measurements can be made on various parts of the test piece.

From all the data so obtained, including periodic measurements of pressure made at various positions along the test piece, the performance and effectiveness of that water drive can accurately be determined. From a series of similar runs, changing only one independent variable at a time, the effects of such changes on oil-production rates and quantities can be determined for the circumstances of the tests. From a series of tests, sufficient in number and including a reasonable coverage of the more widely varying conditions experienced in the field, a broad understanding of the factors affecting oil recovery by water drive, natural and artificial, can be realized. From this in turn the economic consequences of variations in the several controllable conditions can be determined.

It is true that the breaking up of each test piece at the conclusion of a run introduces the theoretically undesirable circumstance of using a new test piece for each run. But unless and until it can be shown that the quantities and distribution of the residual fluid contents can be accurately determined (possibly with radioactive tracers) without destroying the test piece, this procedure seems necessary. Any abnormal physical condition present in a particular core should be revealed by abnormal point-to-point pressure gradients or by abnormal relative or effective permeabilities for the several runs.

Further, it has not been shown that the reuse of a single test piece assures the necessary identical initial pore-surface and fluid-arrangement circumstances for a series of runs. Crude, in contact with sand, deposits some organic material on that sand.[3] This, potentially at least, changes the characteristics of the surfaces involved. Organic material so deposited can be removed with chromic acid but that operation would introduce other uncertainties.

At the present state of the art it is far more important to preserve the identical surface characteristics of solids and liquids than to preserve identical permeability and porosity conditions. It would be best to preserve both, if proper means can be devised.

Prior to and during the water drive the crude oil must never be exposed to air.[4] It may even be important to free the driving water of dissolved oxygen before introducing it into the test piece. The fact that most waters used in the field contain dissolved air does not alter this situation. To the extent that oxygen so introduced into the sand combines with some constituents of the crude in the field, this reaction is complete before the water near the flood front has traveled far, thus providing essentially oxygen-free water in the critical zone in which motion is being transferred from water to oil. The very short drive in the laboratory cannot duplicate this condition except through the use of oxygen-free water.

Conclusions

The laboratory procedure outlined here is elaborate. The prosecution of this work would be time-consuming and expensive. But this work in conjunction with that reported from various laboratories can take most of the guesswork out of water-drive operations. It can replace opinion with fact. Any simplification of this program, until proved harmless, would introduce uncertainties which would cast doubt on the value of the whole procedure so far as the application to field work is concerned. Work on this problem has been carried on in many laboratories. Many of the details discussed here are not new. Some of the work previously done is a simplification of that proposed here. As a result of the past work, a broad understanding of the problem has developed; the natures of some of the causes and effects have been generally outlined. But there is a conspicuous lack of concurrence on the findings. For instance, some investigators report that high pressure gradients and velocities result in greater ultimate oil production, some report less, some report no effect. The differences in conclusions reached by various investigators may be traced largely to differences in the circumstances in the laboratory work. The differing conclusions do not mean that anybody is "wrong." All may be correct, each for the circumstances of the particular work. But only to the extent that simulation of field conditions is realized is it proper to apply these findings to field operations. And field conditions vary widely.

With the invaluable background of the excellent work of many laboratories, the writer believes that the time has arrived to proceed with the comprehensive investigation. The quantity of oil involved is so great, the need for the most effective oil production is so serious and promises to remain so, that the cost of this proposed investigation is justified many times over. The work should be undertaken promptly. Literally, "time is the essence" of this investigation.

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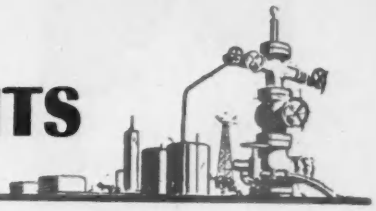
[3] Harry M. Ryder: "Character of Pores in Oil Sand," WORLD OIL, Vol. 127, No. 13, April, 1948.

[4] F. E. Bartell: "Function of Water in the Production of Oil from Reservoirs," API Fundamental Research on Occurrence and Recovery of Petroleum, 1944-1945, page 59.

How to do it!

PRODUCTION HINTS



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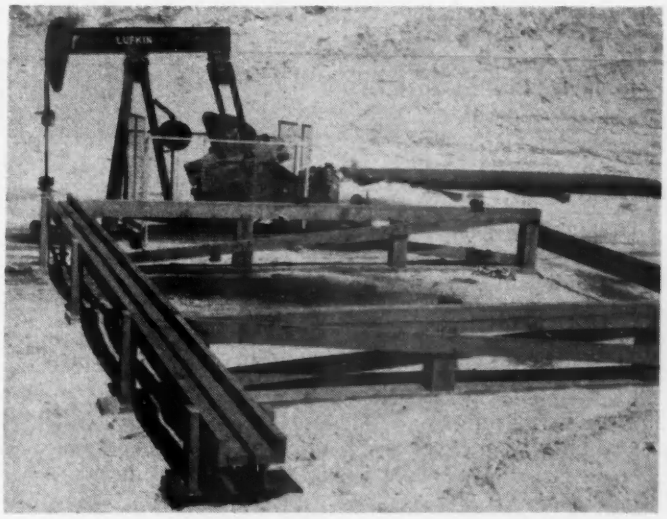
HOW TO—Build Sloping Chute to Handle Tubing



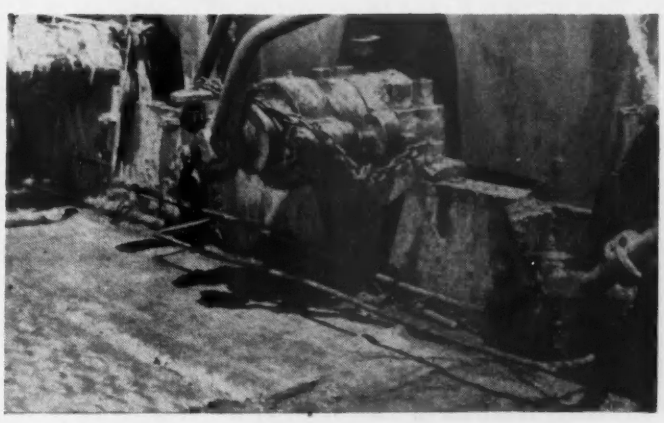
On wells not equipped with a derrick, tubing and rods frequently are pulled in singles and laid down on horses or a rack built beside the well. To speed the handling of tubing when it is laid on a rack, some companies find it desirable to construct a long chute alongside the rack to facilitate tailing out and picking up the single joints.

The chute, which is built so that it slopes downward from the well, can be made of heavy planking, preferably of three-inch material. The floor planking is laid so a fairly wide crack is left in the middle of the runway. This causes the end of the joint to follow along in a straight line when it is laid down or picked up, and provides a drain for fluid that runs out of the tubing.

Another method used by some operators consists of using two joints of old tubing as the bottom of the chute, the "valley" between the joints providing a groove down which the end of the joint can travel with very little friction. The pipe rack itself is so constructed that the two horizontal members are of a height and slope equal to that of the chute. This facilitates the rolling of tubing from or to the chute, and allows tubing to drain properly when it rests on the rack.

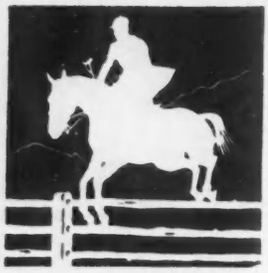
The rod and tubing rack are of sufficient width and so constructed to handle both rods and tubing in singles. Rods pulled first are laid down and rolled to the far right of the rack. These rods may be stacked in as many as three or four rows high. Tubing is then pulled in singles and laid down beside it. Stacking rows of tubing can be done easily.

HOW TO—Make Improved Foot Throttle Control



To save the installation of two separate foot throttle controls, one for the hoisting drum and the other for the sand line drum control positions, the operator of a truck-mounted well pulling unit installed a rectangular-shaped treadle control common to both control positions. Made of round iron bar material, the treadle was welded together into a long rectangle of the shape illustrated. The inner bar of the rectangle was hinged to fittings attached to the side of the drawworks. The device can be made to any length, depending upon the distance between the two control positions. A short lever welded at right angles to the pivot rod was attached to the engine throttle control. Since the one engine drives both the pulling line and sand line reel, the throttle control can be used when operating either of the drums.

Operators of the pulling unit favor this type installation because it is possible for one to position his foot quickly on the throttle rod without having to look down. There is little chance for him to miss the lever in the excitement or confusion of a difficult phase of the work. Also, operators may favor different positions while standing at the controls. The present arrangement therefore simplifies the problem of positioning a control suitable to all who might operate the unit.



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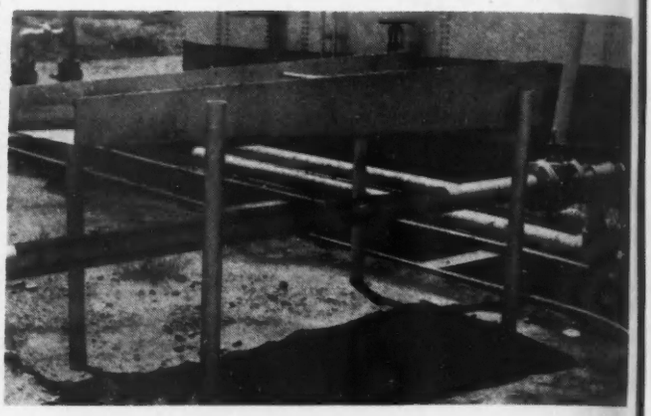
HOW TO—Facilitate Tank-Cleaning Job

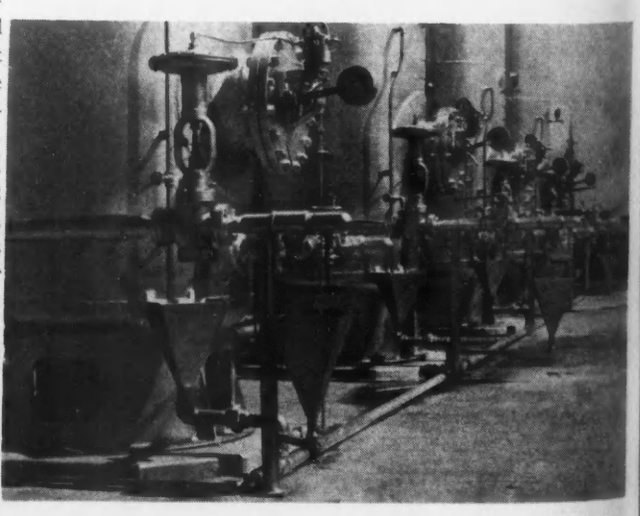


A maintenance job that has one of the lowest popularity ratings among lease workmen is that of cleaning out production tanks. In addition to the unpleasant task of wading through the slimy accumulations inside the tank, workmen must shove the material out to the clean-out-hatch, and must rehandle the material to put it aboard trucks or wheelbarrows for further disposal.

To eliminate some of the double-handling of the bottom material, one company employs a chute-like device which enables workmen to shove the material directly from the tank out to a waste ditch six or eight feet distant, at which point a stream of water can be used to sluice it farther away.

The chute shown in the photograph is made of salvaged tank siding material. The sides are braced internally with a length of pipe, partly visible, and are tapered to facilitate handling of the material. The wide end is designed to fit under the lip of the cleanout hatch. When not in use, the chute is painted and stored atop an elevated four-legged rack near the tank battery. The cost of materials and labor involved in the construction of such a system is repaid by the crew time saved in a few tank cleaning jobs.

HOW TO—Collect Waste Oil Drippings



On oil and gas separator batteries and tanks where frequent sampling is done, the waste from the sample cocks can be collected in funnels and drained to a pit where the fluid can be salvaged. Funnels found satisfactory for this purpose are made of galvanized sheet metal and shaped in the form of inverted pyramids. The base of the pyramids is large enough to prevent spills and slopovers when a sample is hastily taken.

These pyramidal funnels are inverted with the apex attached to a pipe fitting connected to a common drain line. The piping supporting the funnels is installed on swings so the funnels may be moved from side to side in an arc for the convenience of the sample taken. Line flow funnels are placed at the most convenient point and near other funnels below sampling lines when quantities are to be taken from the tank, separator or vessel.

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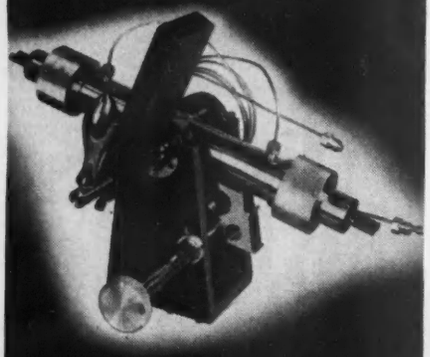

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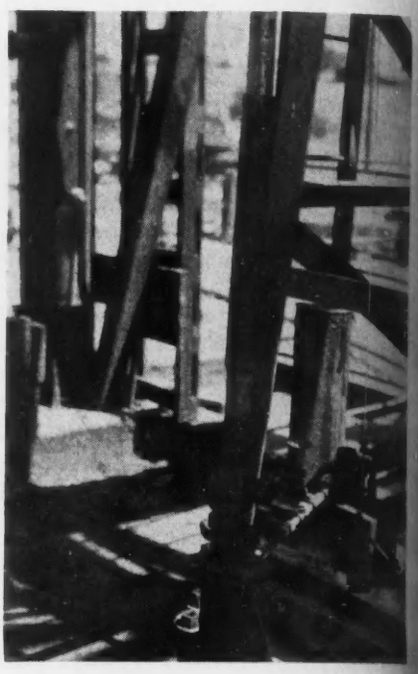
SPECIALIZING in MODERN SECONDARY RECOVERY

HOW TO—Install Tail Pump Connector

Tail pumping crude oil or waste water by means of an auxiliary pump actuated by a connector bolted to the walking beam is a common practice. Such a method, however, generally calls for some means of rapidly connecting or disconnecting the unit without excessive labor, and without shutting down the well for a long time. In the installation shown is a simple type of connector which fulfills practically all the requirements for smooth operation of such a unit. Use is made of a telescoping pipe connector, the upper section of 1½ inches in diameter being connected to the walking beam and the lower segment of two-inch pipe being connected to the tail pump plunger.



A narrow rectangular slot about one inch long is cut through the two tubes in such a manner that when the beam is at its lowest point of the stroke the slots in both segments of pipe will be in alignment. When they are aligned, a short length of flat steel bar is thrust through the slots. This provides a solid coupling between the beam and the pump plunger, yet, when desired, the bar can be pulled out and the pump will remain inoperative, the upper tube then continuing to move up and down inside the lower barrel. To start the tail pump, it is necessary only to thrust the bar through the holes when the well pumping unit is at the bottom of its stroke.

To reduce wear between the two tubes when the tail pump is out of service, it is recommended that a small quantity of grease or heavy lubricating oil be smeared over the surface of the smaller, moving tube.

HOW TO—Shore Up Wooden Derrick Leg

In the majority of cases where wooden derricks have become weakened through lack of repair or general weathering, companies have chosen to pull them over or dismantle them for salvage lumber. In certain instances, however, it may be desirable to repair the derrick and keep it in service a while longer. In one of the latter instances, a company found that the derrick was in danger of tilting due to shifting of the earth on the down-hill side of the slope.

Rather than junk the derrick, which otherwise was serviceable for well pulling purposes, arrangements were made to shore up the outer legs using a length of strong oil well casing set in a heavy concrete footing. The length of pipe, of 11¾-inch size, was capped with a 20-inch square piece of one-inch steel plate as shown. The derrick leg base plate is rested atop the steel base.

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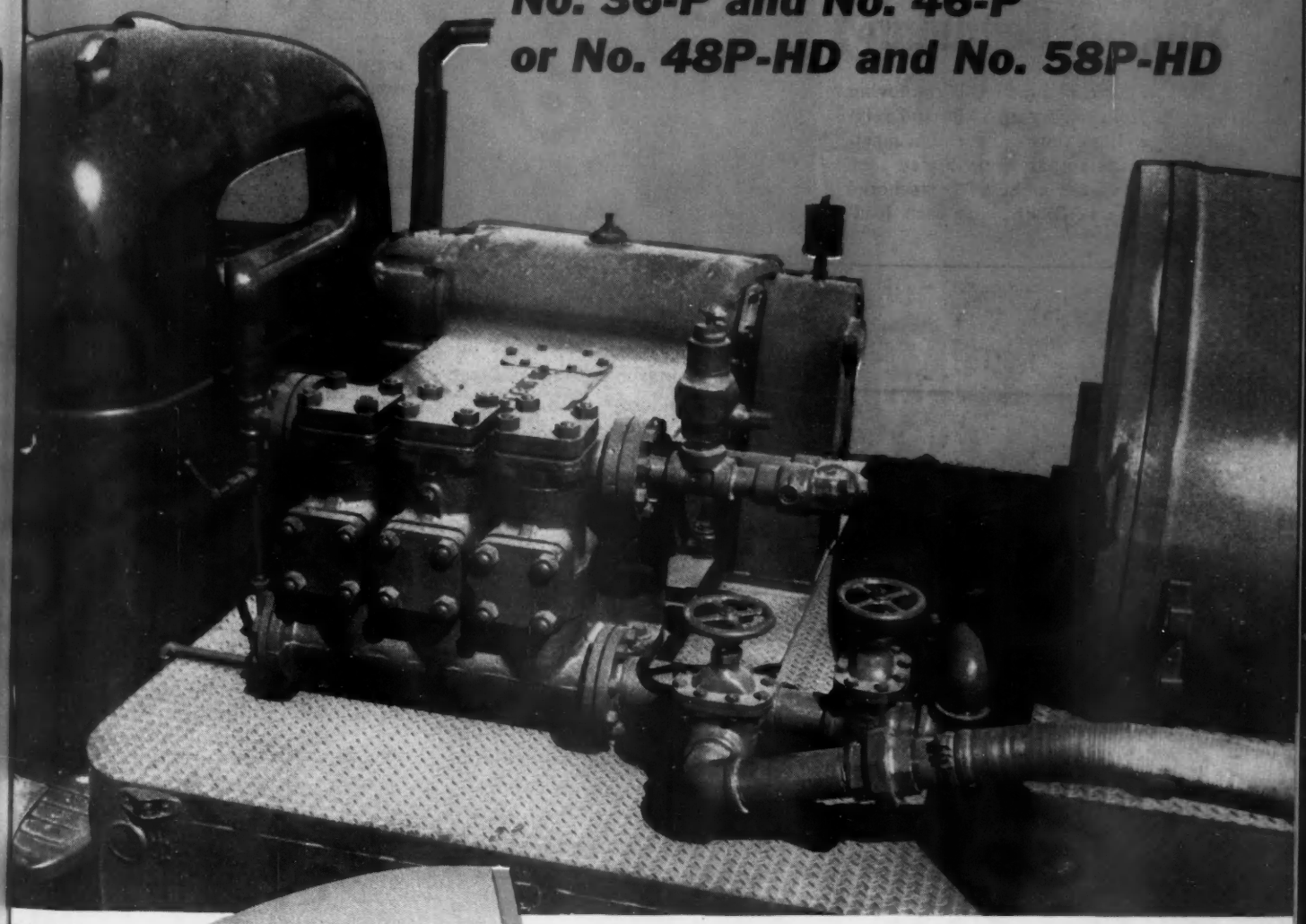

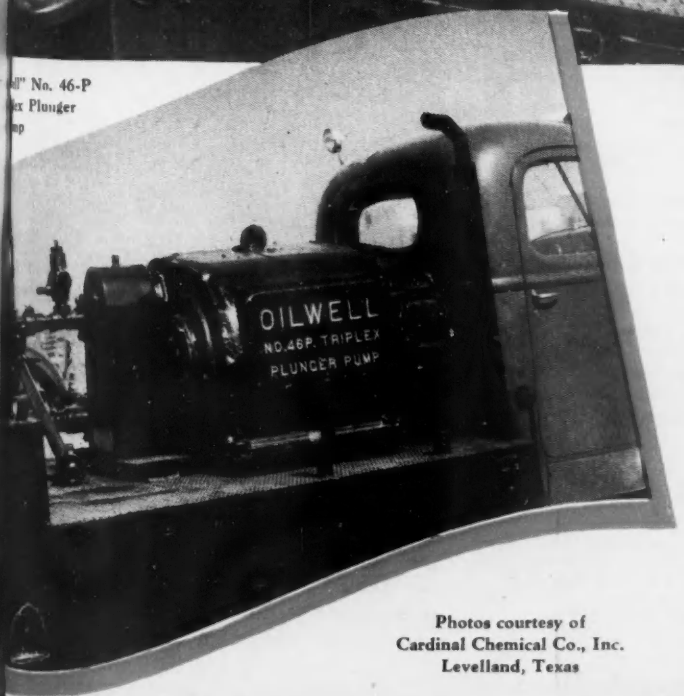

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HOW TO—

Support Deadman

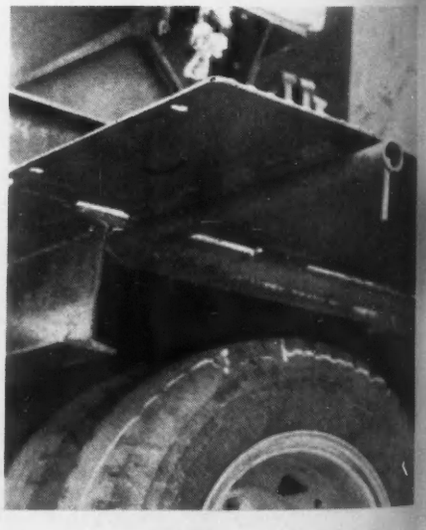
The widespread practice of removing derricks from producing wells and relying for well pulling on portable mast-equipped units has emphasized the importance of having securely anchored and dependable deadmen at each location. A weak point in some deadmen is the eye or connection to which the rig guy line is attached. When a heavy strain is placed on a guy line there is the possibility that this eye will open up or perhaps fail.

One company, to make sure that such eyes will be dependable, has adopted the practice of welding a pair of heavy steel gussets to the eye, one on either side, as shown. The gussets, of one-fourth-inch steel plate, are carefully contoured so that they will fit the eye, then are electric welded on both sides to make a solid unit of considerable strength. By making up deadmen to the same set of dimensions, many such units can be made up without necessity of hand-fitting the gussets in each case.

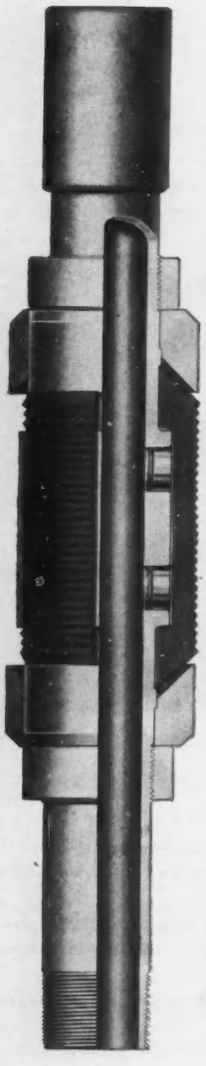
HOW TO—

Make Floor Plates

Use of extra heavy floor plates and an improved method of lending additional strength to them when they are in the horizontal position, will provide extra safety for the men and increased serviceability to that portion of the truck-mounted well pulling unit. Made of heavy diamond-tread floor plate, the walkways are hinged to the edge of the decking projecting from the side of the pulling unit. Beneath the plates, along the line of contact with the telescoping pipe members supporting the decking, are welded pads of flat steel bars. These pads not only add strength to the plates, but take up wear that normally occurs at those points caused by vibration.



Holes burned in the sides of the plates provide a means of pulling up the floor plates to a vertical position and chaining them to the side of the unit while moving between wells.



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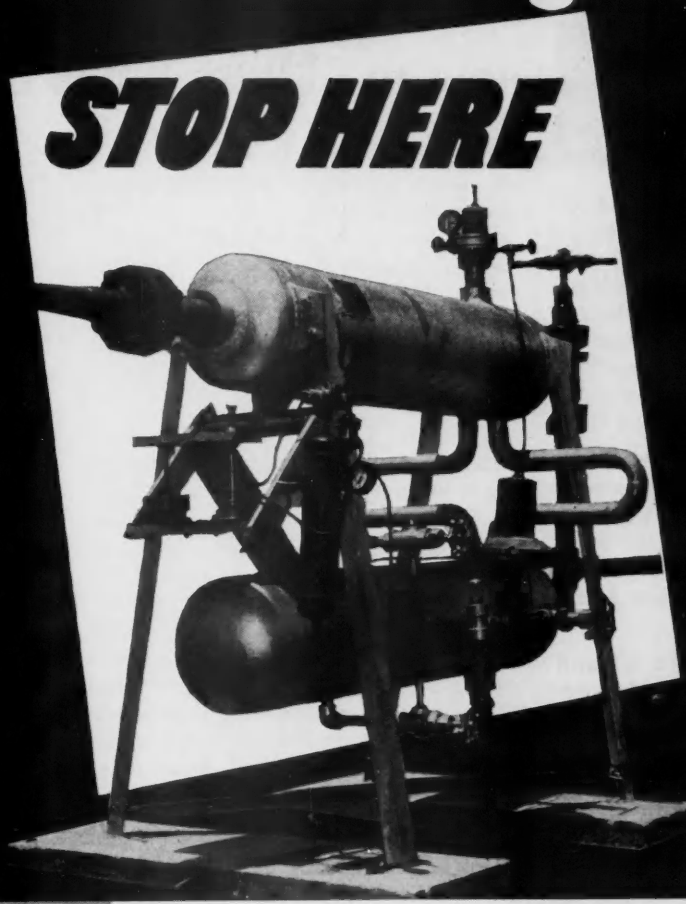

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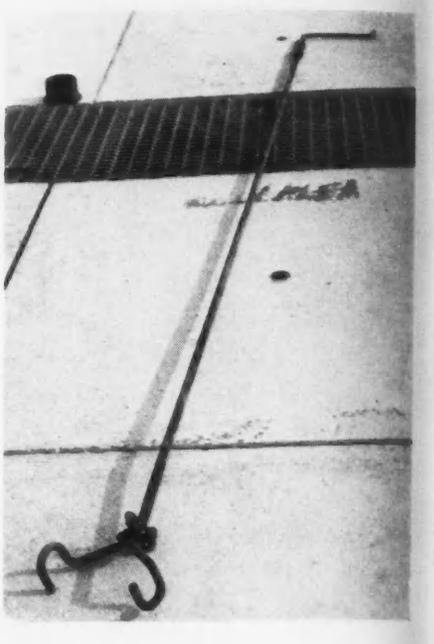
PRODUCTION HINTS

HOW TO—Make Valve Extension Handle

An extension valve turning handle device which is adaptable for use on nearly any underground pipe line or production installation can be built by the company welder out of salvaged rod and pipe materials. A desirable feature of this particular type of handle is the provision made for turning the wheel without need for perfectly aligning the handle with the axis of the valve stem.

The extension is made of a length of sucker rod which is fitted with a hand crank at the upper end, and a shop-made universal joint fitting and pair of spoke-gripping arms on the bottom. The universal joint consists of a simple cross of one-half inch pipe, the curved connectors of the handle and hook sections being inserted into the appropriate parts of the cross. The size of the spokes and diameter of the valve wheels to be operated determine the distance that should be allowed between the oppositely-curved fingers of the gripping device.



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Huge ditching machines cut a ditch four feet wide and from six to eight feet deep along the right-of-way for the 30-inch pipe.

By J. E. KASTROP
Gulf Coast District Editor

The *Transcontinental* Gas Pipe Line

THE biggest undertaking in pipe line history is well under way as Fish Constructors, Inc., Houston, pushes construction on the longest and largest pipe line project in the world.

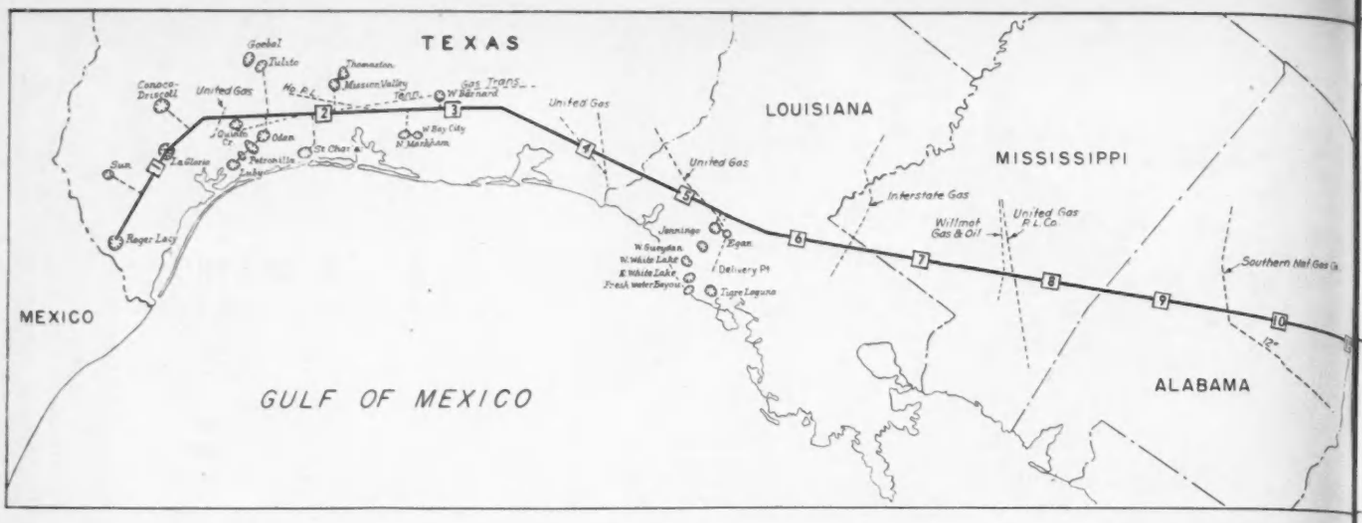
When completed, Transcontinental Gas Pipe Line Corporation's large gas line will extend from the lower Rio Grande Valley near Mercedes, Texas, to the east bank of the Hudson River at 132nd Street, New York City. The line will fork at Newark, N. J., parallel and cross the Hudson River for a second terminus to be established at Greenwich, Conn. The completed line will embody 1876 miles of main trunk line plus 488 miles of gas feeder and sales distribution lines. Scheduled for completion early in 1951, the line will cost an estimated $242 million.

A manager-engineering-constructor's contract for the entire project was granted to the Fish Engineering Corporation of Houston, and its affiliate, Fish Constructors, Inc., for the complete design, engineering and construction of all phases of the line. This is the largest single contract of its kind in the history of the natural gas industry.

First phase of this cross-country project, referred to as Plan I, will provide a capacity of 340 million cubic feet of natural gas daily to Eastern consumers late in 1950. To move this enormous quantity of gas will require 72,000 compressor horsepower distributed through ten stations along the line. Under Plan II, the ultimate capacity of the line will be increased to 505 million cubic feet of natural gas per day by stepping up the compressor horsepower to 210,000 distributed over 20 compressor stations.

It is estimated that approximately 4 million utility customers in the Middle Atlantic area will be served with natural gas from Texas and Louisiana. Most of the gas to be sold by Transcontinental will go to utility distributing companies in the Eastern areas as a replacement for fuel oil and manufactured gas. Homes that will share in the new gas supply are located in the five boroughs of New York City; substantially all of Westchester County, N. Y., and Long Island; much of northern New Jersey, including Newark and Elizabeth; portions of Delaware, Chester, Montgomery and Bucks

HERE IS THE STORY of the longest and largest pipe line project in the history of the gas industry. The tremendous demand for the comforts and conveniences of natural gas in the East will be joined to the abundant supply of this valuable natural resource in the gas-rich Southwest by the Transcontinental Gas Pipe Line, described herein from financing to construction.



counties, Pennsylvania; and Wilmington, Del.

Companies which will distribute the gas under the Federal Power Commission order are Consolidated Edison Company of New York; Brooklyn Union Gas Company; Public Service Electric and Gas Company; Philadelphia Electric Company; Long Island Lighting System; Kings County Lighting Company; Brooklyn Borough Gas Company; Elizabeth Consolidated Gas Company; and South Jersey Gas Company.

Background of Project

Transcontinental, founded by Texas people with Texas capital, made application to the Federal Power Commission in Washington, D. C. in December, 1946, for a certificate of public convenience and necessity for the largest and most costly natural gas project ever to come before the group. Original hearings began in October, 1947, and lasted until February, 1948. They were reopened on May 11, 1948, and on May 29, FPC authorized Transcontinental to construct and operate a natural gas pipe line from the Gulf Coast Area of Texas and Louisiana to New York City. Less than one year later, on May 23, 1949, Claude A. Williams, president, Transcontinental Gas Pipe Line Corporation, turned the first spade of earth near Laurel, Miss., to inaugurate the construction program.

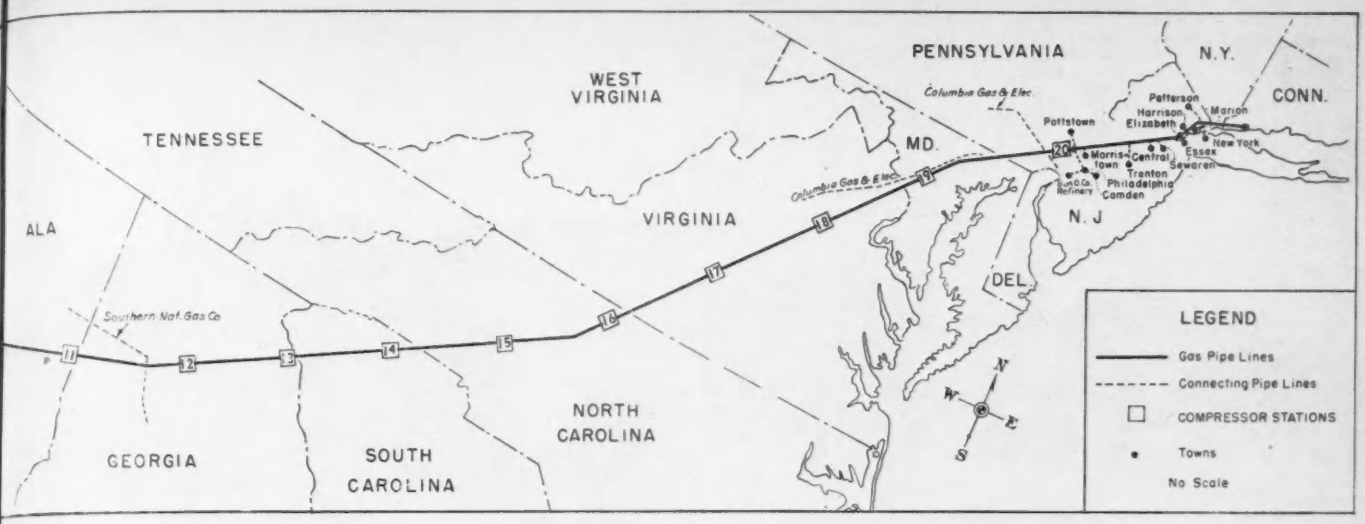
Prior to obtaining FPC approval, Transcontinental had to demonstrate that it had sound financing, was under the leadership and direction of responsible individuals, had the materials available, and had both markets for and supply of natural gas. Of the huge sum required to finance construction of the line, not one cent was borrowed from the federal government. Of the initial amount raised for this project, $26½ million was raised through interim notes which were made payable at a later date in preferred stocks; $28,247,309 was obtained through capital stock and surplus; and the largest sum, $143 million was added by the sale to 18 insurance companies of first mortgage bonds at 3⅝ percent interest due in 1968. Metropolitan Life Insurance Company, the largest single bond purchaser, bought $70 million worth of first mortgage bonds.

Transcontinental had to show further that it had adequate natural gas reserves under contract to fulfill specified rates of gas delivery for a period of at least 20 years. Contracts were made with oil and gas companies in Texas and Louisiana to provide withdrawals to meet FPC delivery rates from gas reserves totalling 2½ trillion cubic feet. Under Plan II, Transcontinental will increase its line capacity to 505 million cubic feet daily by the addition of ten compressor stations, making a total of 20 stations on the line. An application for this increase in line capacity is now pending before FPC. To meet the gas reserve requirements under Plan II, almost 4 trillion cubic feet of gas reserves are now under contract. Known estimated reserves of natural gas in the Gulf Coast region traversed by the line exceed 50 trillion cubic feet. Under Plan II, 51 fields will furnish the necessary gas to supply 505 million cubic feet daily.

The main trunk line will consist of 1569 miles of 30-inch, 5 miles of 26-inch, 192 miles of 24-inch, 26 miles of 20-inch, 43.5 miles of 14-inch, and 35 miles of 10-inch, plus 381 miles of gas feeder line and 107 miles of gas distribution sales lines. Originating in the Rio Grande Valley near Mercedes, Texas, the route passes by Alice, Victoria, just north and west of Houston, north of Beaumont, Texas, Lake Charles, La., and across the Mississippi River about 50 miles

Welders running a bead around the 94-inch circumference of the line in terrain where welding equipment often had to be pulled out by tractors.

Four-thousand pound river clamps are bolted to the line in swampy areas to hold the pipe below the water in order that it could be covered.



north of Baton Rouge, La. The line will then travel in a general northeasterly direction near Montgomery, Ala., and Athens, Ga. It will then turn in a general northerly direction, passing near Spartanburg, and Winston-Salem, N. C., Lynchburg, Va., west of Washington, D. C., north of Baltimore, Philadelphia, and into Linden, N. J. It will go farther north through Elizabeth and Newark, N. J., and across the Hudson River to its terminus in New York City.

Pipe Supply

Main line pipe is being made from flat plate steel which is rolled, welded and expanded. The Kaiser Company has contracted to furnish 500,000 tons of steel plate over a period of about 24 months from its mill at Fontana, Calif., at a minimum rate of 15,000 tons per month and a maximum rate of 25,000 tons per month. Consolidated Western Steel Corporation is fabricating this steel plate into pipe at its Maywood, Calif., plant. Both 30-inch and 26-inch line pipe will be made here. The 30-inch pipe will have a minimum yield strength of 52,000 pounds per square inch. Twenty-inch main line pipe, six-inch to 16-inch lateral pipe, river crossing pipe and miscellaneous pipe will be fabricated by the A. O. Smith Corporation at Milwaukee, Wis. An estimated 25,000 railroad carloads will be shipped from the California plant to distribution points along the right-of-way at a cost of about $20 million.

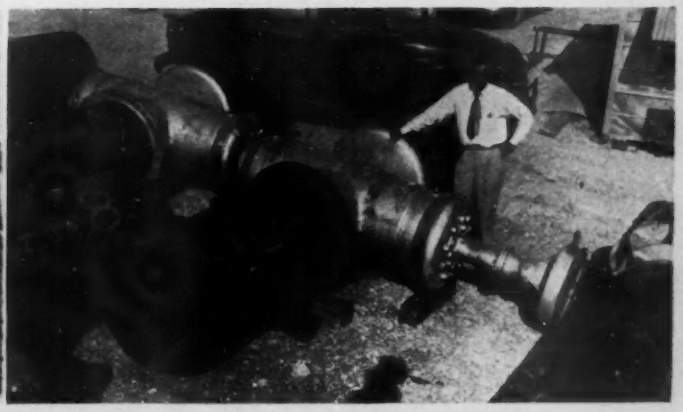
Construction of the entire project has been divided into the 1949 construction program and the 1950-51 program. Under this year's program it is expected that 605 miles of main line plus five compressor stations will have been completed. The 1950 program will terminate the first phases of the line under Plan I when gas is delivered to the Atlantic Seaboard by October or November, 1950. Ultimate capacity of the line under Plan II will be provided by the spring of 1951.

For the purpose of administration, construction is separated into two phases: (1) pipe line construction; and (2) compressor station construction. Each station will be built under the immediate supervision of a construction superintendent on the job. Main line construction has been divided into eight major divisions, each division headed by the division superintendent, who directs all construction activities within his district.

These main divisions are further subdivided into construction schedules averaging about 100 miles each in length. Smallest schedule in distance only is located on the eastern end where the construction problem will be extremely difficult due to the concentration of industry and residential areas. The longest schedule, near the line's origin, is 157 miles long. There will be a total of 19 main line construction schedules on the entire line. At this writing, Schedule 2 (see strip map) crossing parts of Louisiana and Mississippi is practically complete, while Schedule 4 in Alabama is approaching completion. Pipe line construction in Divisions 3 and 4 totalling 605 miles, is scheduled for completion this year, and includes that part of the line from Eunice, La., to Athens, Ga.

Contracts Let

Pipe line construction contracts covering the 1949 program have been let as follows: Schedule 1 and 2 to Morrison Construction Company, Inc., Austin, Texas; Schedule 3 to Wunderlich &



Left: **Welded joints along the line are X-rayed to insure a satisfactory bond between the two metals.**
Right: **Relative size of the large station block valves is illustrated by the man standing alongside one of the shop-fabricated units. A nine-foot joint is welded to the valve on either side with an eight-inch nipple added on either side for blow down valves.**

TOP LEFT: Smooth contour bends in the large line were made by this machine which is mounted on half-tracks and towed by tractors.

★

TOP RIGHT: Equipment and crew for wrinkle bending the 30-inch diameter line.

★

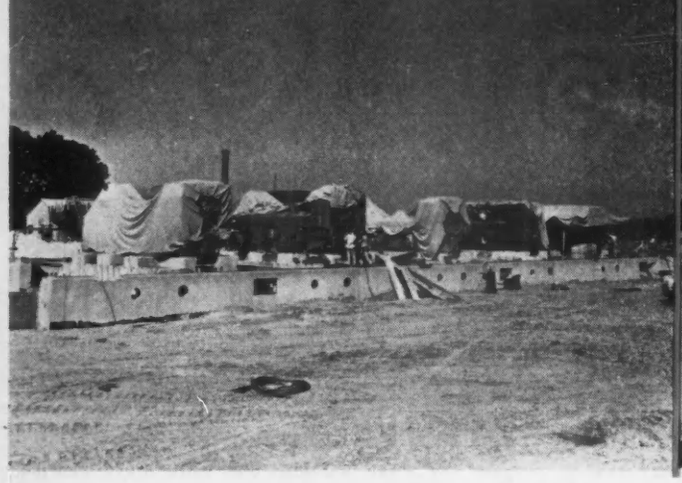
RIGHT: Ground tabs welded to the line at one-mile intervals permit periodic checks on the electrical action between the metal pipe and the earth.

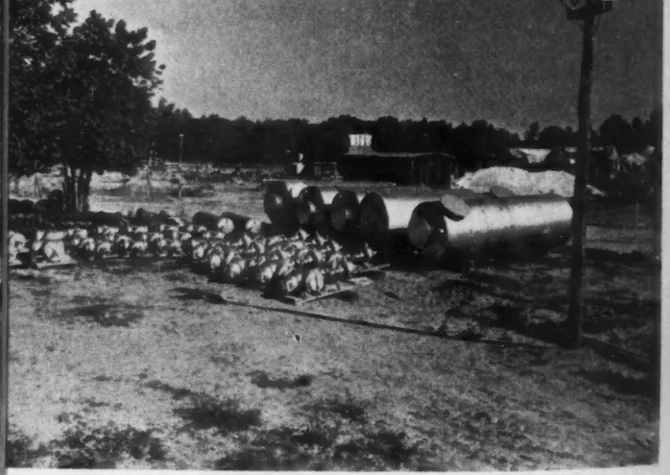
★

LOWER LEFT: Five large compressors on their foundations as Station Six near St. Francisville, Louisiana, nears the halfway mark to completion.

★

LOWER RIGHT: Valves, exhaust silencers, and other equipment are stored at the compressor station site ready for installation.





Griffis Construction Company, Tulsa; Schedule 4 and 5 to Midwestern Constructors, Inc., Tulsa; and Schedule 6 to Williams Brothers Corporation, Tulsa. Shamrock Construction Company of Chetopa, Kansas, has contracted to double-joint 30-inch line pipe on Schedules 1, 2 and 3 with the automatic submerged arc welding process. River crossing contracts have been awarded as follows: Tombigbee River, Alabama, Pearl and Mississippi rivers in Louisiana to Omaha Dock & Dredge and Farley Company; and the Coosa River crossing in Alabama to Austin Bridge Company.

Engineering Features

This 1876-mile natural gas carrier is designed to operate at a maximum of 800 pounds per square inch, with the exception of that part of the line beyond Linden, N. J., where the pressure will be regulated to a maximum of 400 pounds pressure. Throughput is based on 95 percent transmission efficiency with calculated gas volumes corrected to 14.73 pounds per square inch and a flowing temperature of 60° F. Water content of the gas will be held to a maximum of seven pounds per million cubic feet, and the gas purchased is to have a minimum heat value of 1000 British thermal units per thousand cubic feet.

A large saving in steel was effected by carefully designing the line to the pressures to be carried. Pipe wall thicknesses of the 30-inch main line immediately downstream of the discharge of each compressor station will be 0.325 inches, weighing 103 pounds per foot. This weight pipe is carried a minimum calculated distance where the line changes to pipe of 0.3125 inch wall thickness and weighing 99.08 pounds per foot which extends to the intake of the next compressor station up the line.

Beyond Linden, N. J., the line will have for the most part a wall thickness of one-half-inch for added protection in the heavily populated areas.

Line's Right-of-Way

After a careful study was made of the topography over the shortest land route from the Texas border to New York City, a tentative route was mapped. Control points along this route were established and an aerial survey of the complete line was made in a matter of four weeks. This survey consisted of a complete strip map plus numerous mosaics in atlas sheet form and several sheets of stereoscopic prints for detailed topographic study. Where possible, a 75-foot strip was obtained for the right-of-way; however, where valuable crop and timber lands were crossed, this strip was reduced to 50 feet. It is estimated that about 5000 different tracts of land will be involved in the line, and nearly 20,000 individuals will have to be contacted here and abroad to acquire the right-of-way.

A side-boom tractor prepares to lower the line into the ditch before moving on down the right-of-way.

After the actual route was selected from topographic, county, aerial and other available maps, the right-of-way had to be surveyed on the ground and staked off. This involved scouting, hubbing, field surveying and actual mapping. Surveying the right-of-way is nearly completed with the exception of the southwestern leg of the line. Acquisition of right-of-way is proceeding rapidly, with the extreme tips of the line yet to be acquired. The line will traverse 12 states, 109 counties, 110 railroads, 619 state and U. S. highways, and 76 rivers, 12 of which are major crossing projects.

Twenty compressor stations comprising 210,000 compressor horsepower divided approximately equally among all stations are included in ultimate plans. These stations will be about 80 miles apart and each will be equipped with 30-inch station block valves which have been shop fabricated. A nine-foot section of 30-inch by ½-inch line pipe will be machine welded to each side of the large valve which is equipped with two eight-inch blowdown valves. Stations five through 12 (see map) will be equipped with five compressor units. Each unit is rated at 2400 horsepower. Stations 13 through 20, having a total of 11,200 horsepower each, will consist of seven 1600-horsepower units per station. Compressor stations west of the Mississippi River will use oil field flare gas for fuel. Each station will be self-contained and independent of outside utilities.

River Crossings

Of the 76 rivers to be crossed by the main line, 12 will be major crossing projects. Only two of these 12 will be of the suspension type. The Atchafalaya River crossing in Louisiana will be a span of 3650 feet with a clearance of 66 feet above water. It is designed to support two 30-inch lines of 0.375-inch wall thickness pipe. The Coosa River in Alabama will be the second suspension-type crossing and will consist of only one 30-inch by 0.375-inch line with a 700-foot span 53 feet above water. The Mississippi River will be crossed at New Rhodes, La., by two lines of 24-inch by 0.937-inch pipe weighing 240 pounds per foot. No river clamps will be required, since this weight pipe is sufficient to provide negative buoyancy. The Hudson River crossing brought about an unusual problem in design since the silty bottom is in a semi-fluid state. In order to keep the 26-inch diameter line submerged to a depth of 25 feet below the silt bottom, pipe weighing 298.9 pounds per foot was required. Wall thickness of this pipe will be 1.125 inches.

Other river crossings, both major and smaller, will be of the submerged type using one-half-inch wall pipe. The Hackensack and Passaic river crossings at the eastern end of the line will be single 26-inch lines with provisions on the Passaic crossing for an additional 26-inch line. A second crossing of the Hudson will be made by a fork of the line just north of the New York City crossing to terminate at Greenwich, Conn. This line will be about 36 miles long and will be 24 and 20 inches in diameter.

Line Protection

The ditch into which the 30-inch line will be laid is four feet wide and varies from six to eight feet deep. The line will have a minimum cover of about 30 inches, the depth depending upon the terrain. In rocky areas, less cover will be required than in swampy areas where the cover will be appreciably greater. The line will be cleaned, primed, enameled and coated with a glass fiber wrapping. An additional coating of enamel and asbestos felt wrapper will be added in severely corrosive areas. Although cathodic protection will not be installed until after the line is completed, ground leads are welded to the line at one-mile intervals in order that a careful study could be made on the electrical losses due to differences in potential between the line and the earth.

That this entire project has been organized and financed without any government aid is a tribute to the officers and stockholders of Transcontinental. Not only will $242 million be put to constructive work and provide employment for thousands, but the availability of natural gas to the eastern consumer will immediately be realized by a higher standard of living derived from the added comfort and convenience of a steady supply of clean, quiet, safe and economical heat.

J&L PIPE

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Line Pipe

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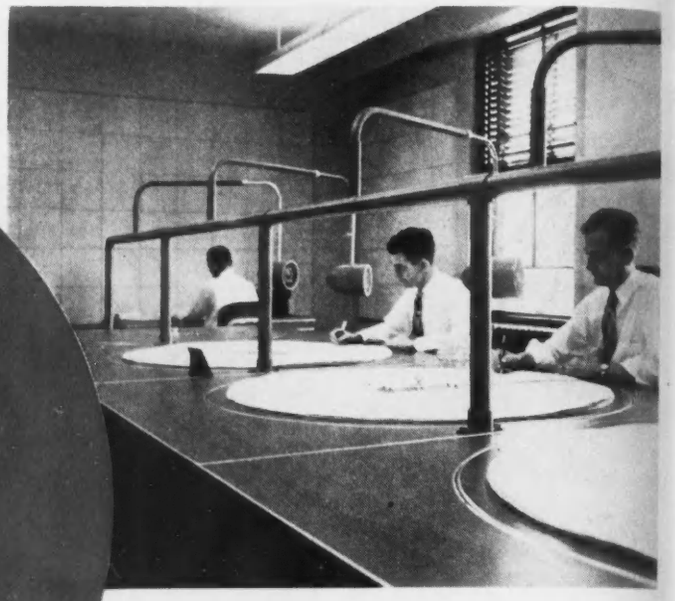
SUPPLY COMPANY

Subsidiary of Jones & Laughlin Steel Corporation

Ask for Bulletin O.C. 5

TULSA, OKLAHOMA

The Great Lakes Pipe Line Company's Dispatching Table



Facing the dispatchers, the pins and rider used to hold the record sheets in place are evident, as is the thick pad of accumulated daily sheets on each of the tables—simplifying the check of previous runs and affording ready file for a month's records.

By ELTON STERRETT
Engineering Editor

USE OF SPECIAL record sheets, cut to ride a four-foot disc, enables one pipe line company to keep accurate track of all movement through its lines with minimum effort, and at the same time provides dispatchers with all essential line information for making emergency decisions.

PIPE line dispatching, whether it be crude, finished products, or natural gas, is a busy whirl, but it remained for Great Lakes Pipe Line Company to translate this motion into efficient physical use. It has done this by means of a circular dispatcher's table. The new table is a long stride ahead in dispatching technique over the old book or flat sheet method, in that it enables the dispatcher to see at a glance conditions all along the line, and to record in the proper place on the master sheet conditions as reported to him by any station on the line.

It is difficult to decide which is the more important of the two features which make the table so successful: the big semi-circular sheets which, paired, make up the background data for each section of the system, or the easily rotable discs on which the sheets are mounted.

Outgrowth of an idea borne from the expansion of the Great Lakes system, the unit consists of a long desk or table, separated into four square sections. Centered in each of the sections is a disc, level with the surrounding stationary portion of the unit, and mounted on a vertical shaft with paired roller bearings to provide easy rotation and maintain accurate alignment of the rotating and stationary surfaces. Near the center of the disc protrude four pins, over which matches a special oblong center weight with a knob for added weight and ease of lifting. The disc is not provided with brake or other latching device, but is free to spin at a finger's touch, yet is rigid and heavy enough to remain stationary as the dispatcher enters notations on the record.

Entering Record

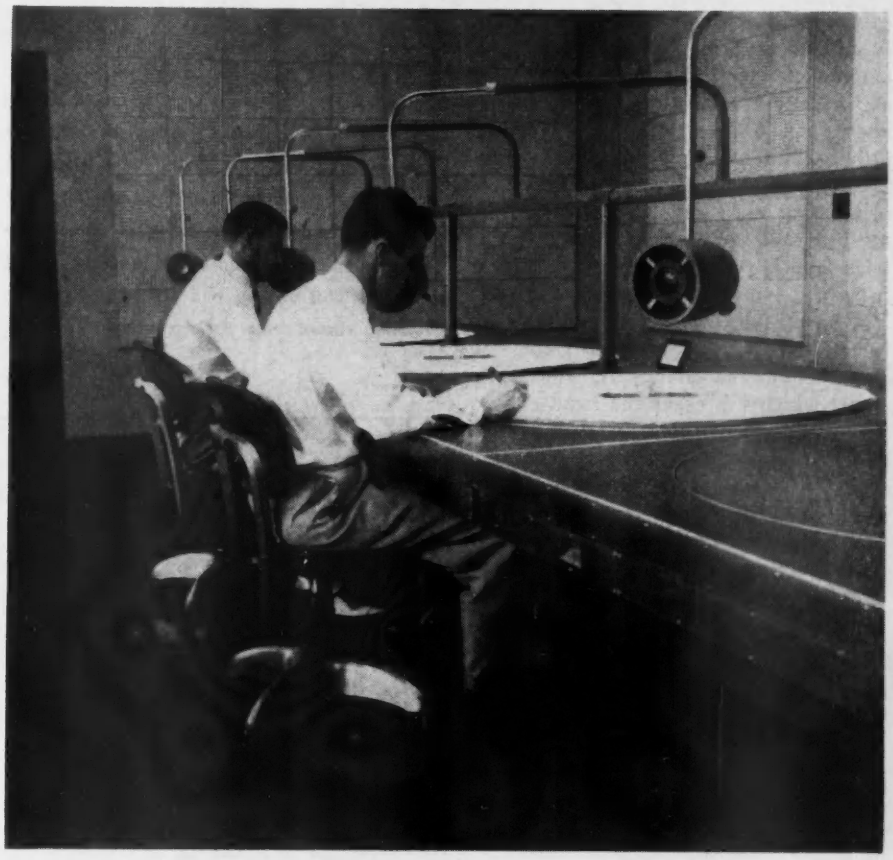
The dispatcher's record is entered on pairs of the semicircular sheets which are attached to the disc through the pins and center weight. Made from a special paper, and each printed with a certain section of the pipe line system, the hourly records are entered in ink, and become a permanent portion of the dispatcher's data.

Beginning at the far left of the long table, the first disc carries all records of the first section of the system, the second another part, and the third disc the end portions of the branches of the present system. A fourth disc is to provide expansion of the records as additions to the system, now under consider-

ation and construction, require additional space for entering records.

A system of microphones, connected to a panel near the central switchboard during the day and controlled from a push-button panel near the dispatcher's table during the other two shifts of the normal 24-hour day, puts each of the dispatchers in touch with any desired station, and enables data to be relayed directly from station to dispatcher.

The record sheet is composed of two parts: one presenting what might be termed fixed line data, the other the flow characteristics of products movement through whatever portion of the system happens to be covered by the segment of sheet in front of the trick dispatcher. Fixed data includes a map of the system, showing all salient features in their exact relationships. A series of equally spaced concentric circles represent elevations above sea level, in increments of 100 feet per one-half-inch interval. Since the line elevation may change through several hundred feet, values are assigned these contouring circles to cover the range in the line carried on any particular disc, both halves of the record sheet having identical elevation circles to provide continuity of the record across the necessary break in the disc at the parting.



Two dispatchers are handling the three sections of the line with individual "mikes" so that conversation may be held with two or more sections at one time. The double row of switch buttons at the dispatcher's right control the circuits over which the "mike" is effective.

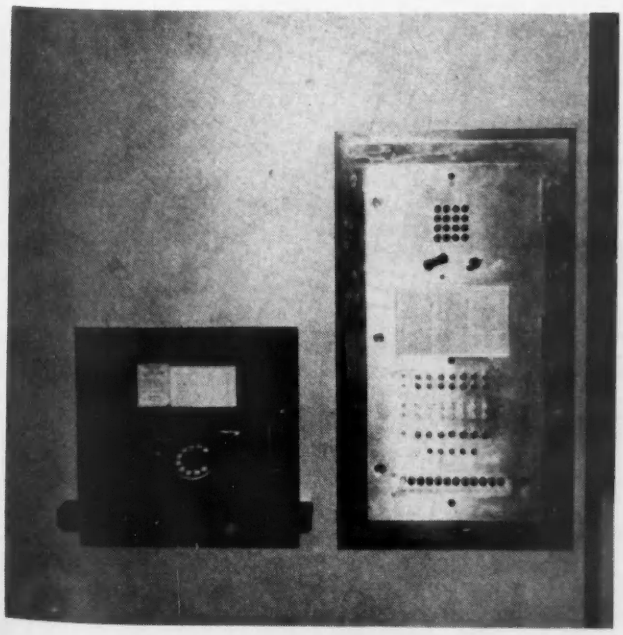
Plotted to Scale

The main line and any branches, if present, are plotted on these contours to scale, so that the difference in elevation, plus or minus, is readily evident from a glance at the sheet. Each block gate is plotted on the sheet in its exact position with regard to elevations, so that a dispatcher, in case of line break, can instantly determine direction and amount of drainage and other physical features which will enter into his shutdown orders. Since elevation changes between block gates are not uniform, it is not possible to plot the line to scale, and the distance between gates is determined from the location data, in miles and hundreds of feet. Line fill, in barrels, is also shown for each section between gates, each displacement figure being underlined with a guide to the section to which it belongs, so as to avoid possible error. The line displacement is figured from each station, and is cumulative to the point shown, for each section. These displacement figures, wherever possible, follow the average contour of the line, so as to further simplify their pickup by the dispatcher.

Each station is indicated on the map by a square, with a symbol indicating the presence of tankage when such is present. A line from the station symbol to the ruled space directly below it—on a radial extension through the station—indicates the station name and provides space for special entries regarding conditions at that station.

The space devoted to dispatchers' entries is ruled with concentric circles for the 24-hour operating day, doubled lines indicating the breakdown into three shifts of eight hours each, from midnight to 8 a.m., 8 a.m. to 4 p.m., and 4 p.m. to midnight. These hourly division numerals are repeated on each radial line, so that it never is necessary to carry a time base over more than a few inches of the chart, making for accuracy in posting entries.

The space under a station heading



Control panel and commercial telephone connection for contacting stations—used when the company switchboard is not available. A dial-type station selector is to be installed at each dispatcher's station, eliminating the multiple switch selector now in use.

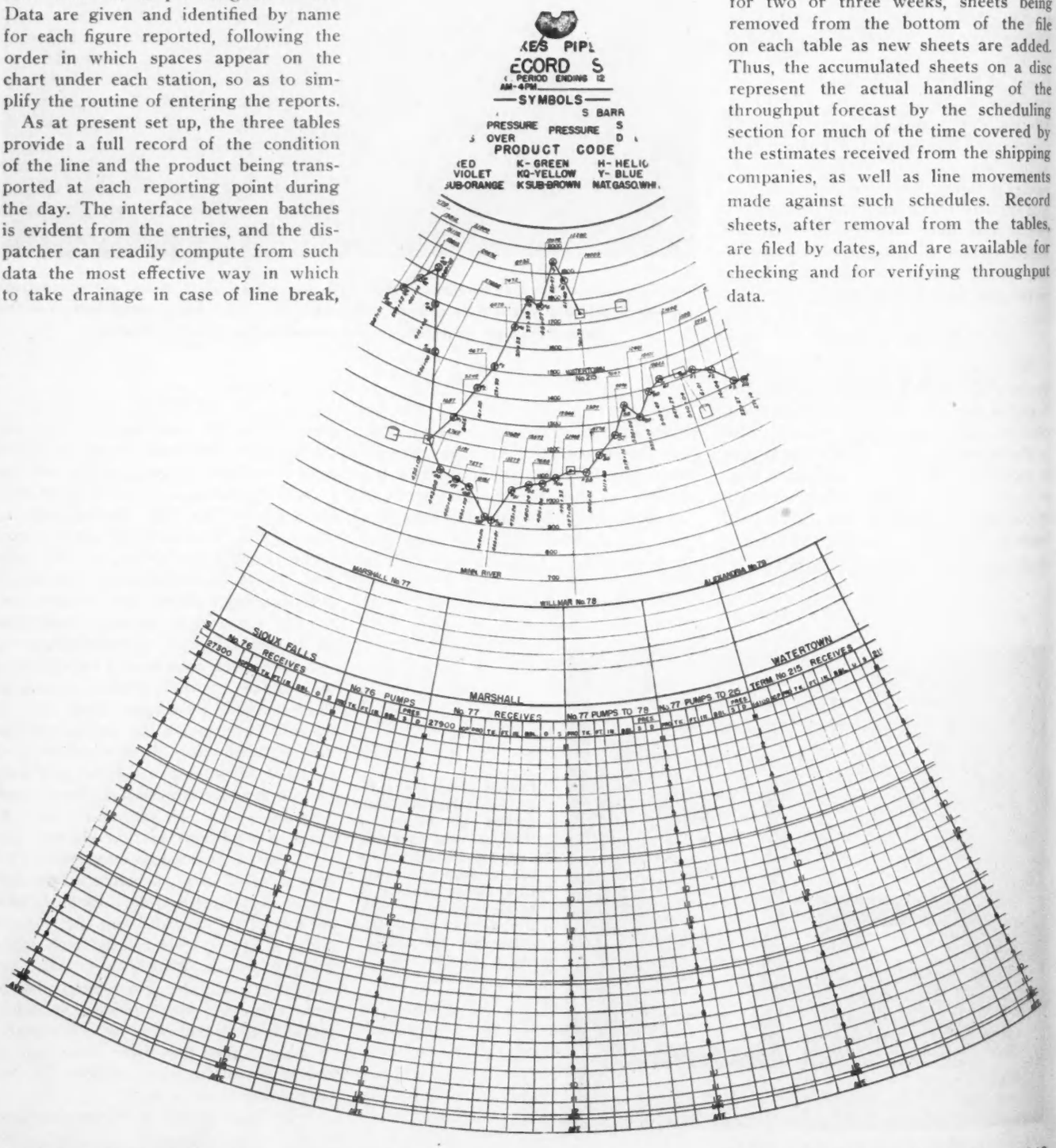
carries the station numerical designation. A column is provided for line fill, the amount of which is shown as computed at the left of each station division just above the first of the hourly spaces. Other columns show product, suction pressure, and discharge pressure. At originating and receiving points, columns are provided for tank numbers, together with hourly gauges which are shown in feet and inches as well as in barrels. The barrel figures are used in computing hourly over and short records for each line section and in posting cumulative totals which represent the head ends of product movements.

All stations in the given line section meet the dispatcher on the telephone each hour at a pre-designated time. Data are given and identified by name for each figure reported, following the order in which spaces appear on the chart under each station, so as to simplify the routine of entering the reports.

As at present set up, the three tables provide a full record of the condition of the line and the product being transported at each reporting point during the day. The interface between batches is evident from the entries, and the dispatcher can readily compute from such data the most effective way in which to take drainage in case of line break, or to divert product to tankage in case of temporary shutdown of a portion of the system.

The dispatching of products over a system such as that of the Great Lakes Pipe Line involves the handling of receipts from nearly a score of sources, each of which is asked to provide, well in advance, a schedule of anticipated shipments for the ensuing month. These figures are received by the scheduling section and then are balanced as to dates and quantities so as to provide a full flow through the line at all times, with the proper sequence of products. All products delivered to the pipe line are held to rigid specifications.

Record sheets are kept on the table for two or three weeks, sheets being removed from the bottom of the file on each table as new sheets are added. Thus, the accumulated sheets on a disc represent the actual handling of the throughput forecast by the scheduling section for much of the time covered by the estimates received from the shipping companies, as well as line movements made against such schedules. Record sheets, after removal from the tables, are filed by dates, and are available for checking and for verifying throughput data.



Section of one of the semicircular record sheets, each made up to cover a specified portion of the line, and printed as a flat sheet, afterward trimmed by hand to fit the 48-inch circle of the table. Contours, block gates, cumulative line displacements, and other data are carried for each unit of line, and placed adjacent to running record from each station or terminal.

By GILBERT M. WILSON
Pacific Coast District Editor

AUTOMATIC CONTROLS, for both over- and under-limit operation, control flow through crude line traversing built-up sections and reduce hazard to community as well as speed throughput handling.

New Controls *Improve Operations* in Densely Populated Areas

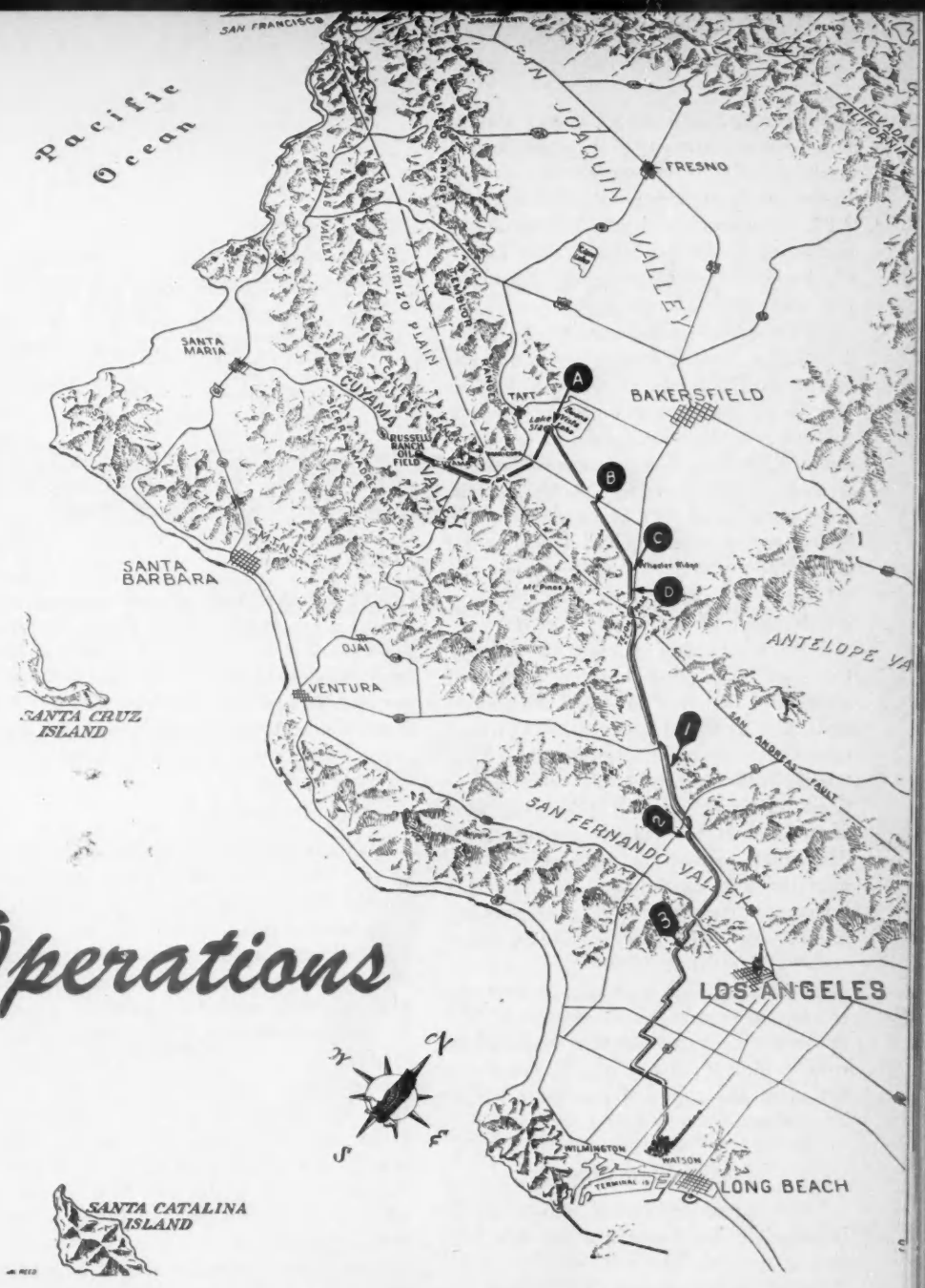


FIGURE 1. Map showing location of Richfield Oil Corporation's ten-inch crude oil pipe line which delivers crude from San Joaquin Valley points to the firm's Watson refinery in the Los Angeles Harbor district. Four pump stations (A), (B), (C) and (D) are required to pump oil up over 4304-foot summit of Tejon Pass. From summit, oil flows by gravity to refinery. Gravity flow control points are indicated at (1), (2) and (3). Also shown on map is the recently-completed 33-mile eight-inch line which brings high gravity crude out of the new Cuyama Valley production area.

IN THE 25 years during which Richfield Oil Corporation has operated a ten-inch crude line between the Midway-Sunset area of southern Kern County and its Watson refinery in the Los Angeles Harbor district, there has been a substantial increase in growth of communities along the route of travel, particularly the last 30 miles of the line. To protect these builtup areas from the inconveniences and possible damage that might occur in the event of a line break, the company recently undertook an extensive program of modernization which included the installation of safety and protectice devices designed to shut off the flow automatically at certain key points in the event pressures should exceed, or drop below, the normal operating range. In addition, a telemetering system was installed by which the operator at his main office in Long Beach can determine instantly the delivery rate at any one of several metering points along the route, and by which he can tell whether all parts of the line are functioning properly. Extensive cathodic protection also was provided for a critical section of the line where it traversed a certain residential area.

Constructed in 1925, the crude line is approximately 127 miles long. It originates at the company's Lake Station at the southwest side of the Buena Vista Lake in the southern portion of Kern County, San Joaquin Valley. As can be seen in Figure 1, the line traverses the rugged Tehachapi Mountains, across the mountainous area north of Newhall, down into San Fernando Valley, up over the eastern edge of the Santa Monica Mountains (otherwise known locally as the Hollywood Hills), then across the Los Angeles Basin to the refinery at Watson in the Los Angeles harbor area. Within the past year, the company has added another segment of line to the northern end of the main ten-inch line. This new section, of eight-inch pipe, is about 33 miles long and carries crude to Lake Station from the company's producing wells in the recently discovered, high-gravity Cuyama Valley area.

Throughput of the main line is approximately 27,000 barrels of oil per day. Oil shipped consists of a variety of crudes produced and purchased in the

San Joaquin Valley and Cuyama Valley areas. Average gravity of the commingled crude, prior to the discovery of Cuyama Valley production, was about 26 degrees API. However, with the continuingly increasing production of Cuyama Valley oil, both average gravity and throughput have been increasing.

As can be seen from a study of Figure 2 the pipe line traverses an extremely rough terrain. From an elevation of 345 feet above sea level at the Lake Station, the line rises to a maximum at the summit of 4304 feet. Four pumping stations, spaced as shown in the profile sketch, and operating at 650 pounds per square inch pressure, are required to carry the oil to the summit. From this point the oil flows by gravity to the refinery, which is at 38 feet above sea level.

The gravity flow portion of the line traverses the most heavily populated areas, and this was equipped with automatically operated pressure control valves, flow metering equipment and extensive cathodic protection. The installations safeguard the densely populated areas against the remote possibility of line break caused by earth movements near the line, earthquake, or other disturbances. Possibilities of over-pressure breaks are considered slight, since records show that through the 25 years of operation so far, no material instances of over-pressure have occurred. The automatic features of the installations enable almost instantaneous corrective action in the event of over-pressure or line failure.

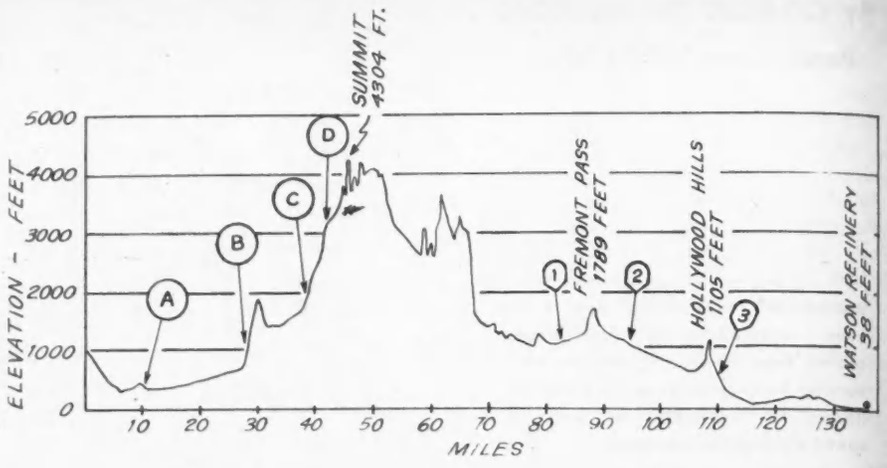


FIGURE 2. Profile sketch of route traversed by pipe line from San Joaquin Valley to refinery at Watson in Los Angeles Harbor district. First approximately ten miles of line is eight-inch feeder delivering oil to Buena Vista Lake Station, elevation 345 feet, at (A). Remainder of line is ten-inch. Other pumping stations are: (B) Wheeler Ridge, elevation 830 feet; (C) Grapevine, elevation 1800 feet; and (D) Fort Tejon, elevation 3075 feet. From summit, oil flows by gravity to Watson refinery at elevation of 38 feet. Gravity flow stations discussed in text are: (1) Newhall; (2) San Fernando; and (3) Laurel Canyon. Telemetering stations are located at Newhall and refinery.

Gravity Flow Controls

Three pressure control stations were installed in the lower gravity flow portion of the line. These stations are at the Newhall pump station, a point on the northern edge of San Fernando Valley, and the third in Laurel Canyon in the Hollywood Hills.

The Newhall control point has two methods for controlling line pressure and shutting down in the event of a line break. Located on the bypass line to the tanks at this station is a small automatic back-pressure regulator valve, the upstream side being subjected to the main line pressure. Set at 580 pounds per square inch, this valve normally is closed, but should pressures in the main line build up to the relief valve pressure, the valve will open and divert part of the oil stream into the tanks, thus serving to lower the pressure to normal. In addition to this automatic equipment, hand-operated valves were installed to enable switching the flow into the Newhall tanks upon discovery of a leak and thus protect lower sections of the line from any danger of over-pressure.

The San Fernando control point, the second station in the gravity flow portion of the line, is on the northern rim of the San Fernando Valley, approximately 11½ miles south of Newhall. This control point, illustrated in Figure 3, is situated at the same elevation as that at the summit of the Hollywood Hills, about 15 miles farther to the south. A standard eight-inch diaphragm-actuated control valve, with a pilot control for sensitivity, was installed at this station. The system is adjusted to maintain a constant back pressure of at least 440 pounds per square inch on the upstream side of the line, a pressure that is equivalent to the static head resulting from the differential in elevation between the San Fernando installation and Fremont Pass, the latter being about midway between Newhall and the San Fernando station. In the event of a line break south of the San Fernando control point, the reduced pressure on that side would cause the regulator to close, thus holding back the oil above the regulator, and regulating flow and line pressure to a valve commensurate with operations at the Newhall station.

The third control point is in Laurel Canyon on the lower, southern slope of Hollywood Hills. The installation is similar to that at the San Fernando control station and performs an identical operation. The regulator here is set to keep a constant back pressure of at least 440 pounds per square inch on the line, a pressure equal to the static head resulting from the differential in elevation between this point and the summit of Hollywood Hills.

Since the installation of the three control stations, necessary adjustments have been made to improve operations, and tests have been conducted to demonstrate effectiveness of the system. These tests consist of placing men at each of the three stations, and at a predetermined time, pumping over the summit was stopped. In each case, the control stations worked perfectly, the automatic control valves at the San Fernando and Laurel Canyon stations closing immediately because of the decreased pressure on their upstream side. Within five minutes from the time the test started, all control points in the gravity control part of the line had reduced or halted the flow entirely.

Telemetering System

In order that the dispatcher can know at the earliest possible moment when a line break occurs, flow meters were installed at both the Newhall station and the Watson refinery, and a telemetering system then installed which transmits readings directly to the Long Beach headquarters of the Pipe Line department. The telemetering system, utilizing existing company telephone lines, records the throughput at each of the two stations. The readings are transmitted on a continuous log (Figure 4) in the dispatcher's office at Long Beach. Self-contained pressure recording instruments are placed at the control stations at both San Fernando and Laurel Canyon, charts at these stations being changed daily by the company line rider.

The entire leak-detecting system is extremely sensitive and provides not only a means of detection, but indicates fairly good limits of the location of any leak should it occur. For example, should a break occur above the Newhall station, the recording instrument at New-

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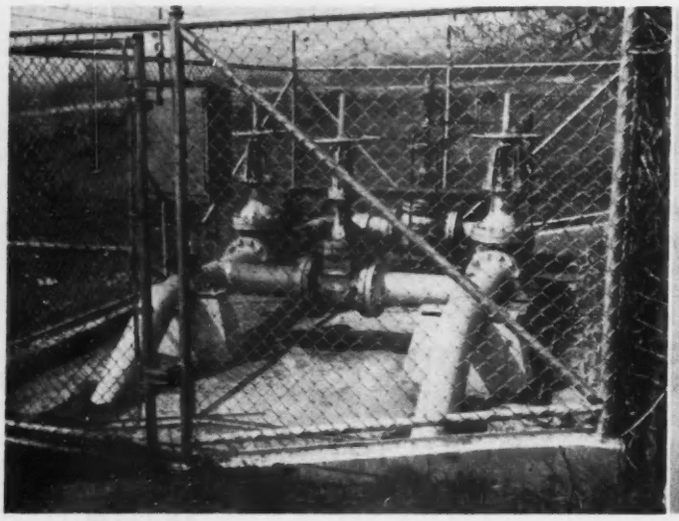


FIGURE 3. View of San Fernando pressure control station located on northern edge of San Fernando Valley. Under normal operating conditions, oil comes in through line at right, passes through regulator-controlled valve at far end of installation, and back into main line through line at left. Valve in center is bypass that normally is closed. If pressure on upstream side falls below 440 psi, regulator valve automatically closes. Any line break occurring downstream from this station would reduce pressure on valve and cause it to close, thus preventing flow of oil still in line above the installation.

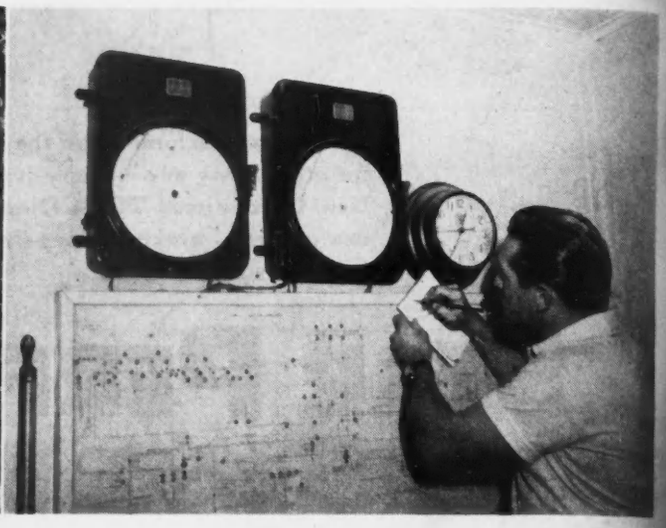


FIGURE 4. A continuous, 24-hour record of throughput at both the Newhall station and the Watson refinery is transmitted through a telemetering system to recording instruments located at the Long Beach headquarters of the Pipe Line department. Here, the pipe line dispatcher is taking down information indicated on the instruments. Interpretation of these charts can indicate to the dispatcher when a line break occurs, and the approximate limits of area in which it is located.

hall would show an immediate large decrease in both throughput and pressure. The instrument at the Watson refinery would show a delayed, smaller decrease, as the lower portion of the line drained. In the event of a line break below, or south of Newhall, the pressure at Newhall would decrease and the throughput would increase. The indications at the refinery would be slower but eventually would show a decrease in throughput. If a break should occur in the line near the refinery, the indication at Watson would be a quick drop in throughput. Such a break, occurring near the refinery, probably would not materially change the indications at Newhall.

A 24-hour watch is maintained on the telemetered, continuously-recording chart in the dispatcher's office at Long Beach. Any change that occurs at the two key stations, Newhall and the Watson refinery, instantly is noted, and within minutes the affected part of the line can be shut off or the flow diverted into tanks so little damage can be done and a minimum of oil is lost.

Cathodic Protection System

In a 4½-mile section of the line in the critical residential zone in Laurel Canyon, additional protective measures were taken. A cathodic protection system was installed to protect against the possible failure due to galvanic action in the soil. With the aid of an underground corrosion consultant, company engineers performed various tests on the line before actual design work was begun for cathodic protection facilities.

The entire length of pipe to be protected was located and subjected to various tests in order to determine the possibility of any metallic contact with other existing lines or subsurface structures. To accomplish this task, two sets of ten-inch insulating flanges were placed in the line to isolate the section to be protected. Test holes then were dug every few hundred feet for this distance and tests were made with electronic and other types of detecting equipment. The tests showed four actual metallic contacts and five near-contacts with other facilities such as other pipe lines and conduits. The line was cleared of these contacts and near-contacts and complete tests then were made to determine the location of the anode and current density required to protect the line.

At a suitable point, an anode consisting of 10 tons of scrap pipe was installed. It was made up of about 500 feet of scrap ten-inch pipe which was strung along a narrow cleared area about 300 feet to one side of the line right-of-way. Joints were welded together, the cable attached, and the entire anode then was buried to a depth of six feet. Several tons of rock salt were mixed with the soil when the ditch was backfilled. When the ditch was completely filled in, it was wet down thoroughly so as to moisten the salt and thereby increase the electrical conductivity between the anode and the surrounding earth.

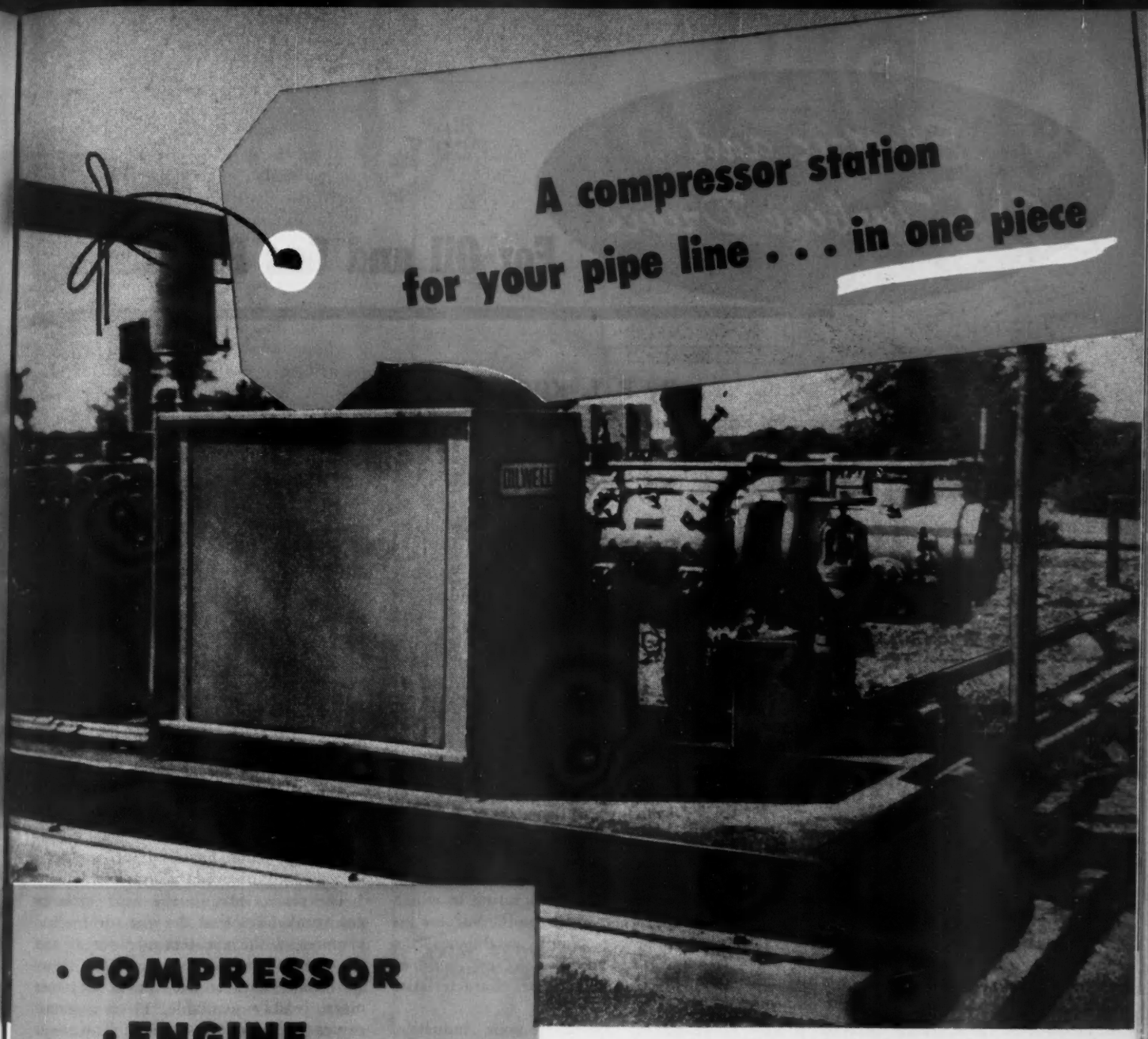
Power to the anode, supplied from regular city supply, is 220-volt, 60-cycle, three-phase, alternating current transformed and rectified, and transmitted to the anode by means of a pole-suspended cable.

Cable Lugs Protected

The cable was fastened to the anode at 20-foot intervals throughout its entire length. It was attached securely by means of heavy copper lugs that were welded to the pipe. After the cable was attached and the lugs tightened, the contact points were enclosed in boxes filled with hot tar. After the tar had solidified, the boxes were removed. Thus protected, the copper lugs are able to withstand rapid subsurface deterioration. A similar method was used in connecting the rectifier cable to the main pipe line.

Upon completion of the installation, the system was placed in operation and subjected to considerable testing and was found to be entirely satisfactory. Although it is perhaps too soon to determine the ultimate value of the installation, it has functioned continuously without trouble or shutdown for approximately a year.

The several new installations added to the existing pipe line system, combined, provide an unusually important degree of protection and safety, not only to the populated areas through which the line runs, but to the company equipment as well. Pipe line operating efficiency is improved, and because of the improved cathodic protection in the critical area, life of the pipe line is extended materially. The installations provide a good answer to the problems that many pipe line companies either now face, or will face in the future, when rapidly expanding populated areas spread over sections of pipe line rights-of-way.



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Electric and Gas-Turbine Drives For Oil and Gas Pipe Lines

By F. L. KAESTLE
Industrial Engineering Divisions, General Electric Company

HUNDREDS of pipe line projects under construction and planned today evidence the increasing importance of the use of pipe lines as means of transportation for gas and oil. The power required per unit of output is increasing steadily. This results from demand for greater quantities of more diverse and higher quality products, and ability to meet this demand by applying more power to the processes of industry.

What is true for the production and processing of gas and oil is likewise true for its transportation to market. Hundreds of thousands of horsepower of equipment are involved in the next few years.

The growing use of high speed rotating compressors and pumps, and drives economically and inherently adapted to them, offers the most promising means to provide reliable pipe line systems which have substantianlly lower installed and operating costs.

Both the electric motor and the gas turbine are ideally suited technically to pipe line service for they are in themselves compact, high-speed, rotary devices.

Where electric power is, or can be made available at favorable rates, electric motor driven pumping stations probably will continue to offer the lowest over-all operating costs obtainable. Approximately one-half of the total horsepower installed in pipe line service today is in electric motors, and the ratio is nearly 70 percent electric for equipment being supplied today.

However, where power must be, or can more economically be produced directly from fuel, the gas turbine is ideally applicable in those ratings for which it can be built economically.

Probable Fields of Application

The selection of suitable drives for pipe line pumps and compressors, as for most industrial apparatus, must be based primarily on over-all economics.

Technically there is now lower limit to the physical size and rating in which gas turbines can be built. Success as aircraft power plants establishes the feasibility of units of a few hundred horsepower where their characteristics justify their use.

However, for continuous industrial service, and with any foreseeable stage of development, studies now indicate that the lower economic limit is 2000 to 2500 hp, with further decided advantages as the unit rating increases to perhaps 10,000 hp. For reasons of flexibility of operation, 5000 to 7000 hp is probably the largest practical drive, even for the largest lines. Therefore, it can be expected that gas turbines will be applied to pipe line service in the range of 2000 to 5000 hp with the earlier units at or near the upper limit, and later applications of smaller units as development progresses. It is interesting to note that one unit of each rating, 2000 hp and 5000 hp, is now on order for gas pipe line stations. Many other units of 5000 hp and greater are now being installed in other industrial services, and so valuable operating experience will be available in the near future.

From surveys of the total network of gas and oil pipe lines in the U. S., it is seen that the average total horsepower per pumping station is only 500 to 800 hp for product lines and smaller crude lines. It is still only 1500 to 2000 hp for the larger crude lines, but up to 12,000 to 18,000 hp for the large gas trunk lines.

Therefore, it is in the field of large gas trunk lines that the gas turbine has promise of the greatest advantages and the widest application. Even for these, as economical electric power becomes more readily available, electric motor drives will compete strongly. The pleasing operating record and results of the Big Inch lines since conversion to gas lines with electric drives serve to emphasize the strong position of electric drives. For product and crude oil lines the trend to more electric drives doubtless will continue.

Expansion of Gas Pipe Lines

Although the demand for oil, gasoline, and other liquid products is steadily increasing, the transportation of greater quantities of these by pipe line is due in a greater measure to a shift from other means of transportation. The economic feasibility of oil and product lines has now been well established.

For gas, however, pipe lines are the only practical means of transportation, and so the extensive gas pipe line projects now planned and under construction are a measure of the greatly increased demand for natural gas. Practical realization of the economic value of natural gas as a basic industrial fuel, even in distant markets, is significant

OUTLINING THE DIFFERENT TYPES of gas turbines available, the author indicates probable fields of use for each, and compares them with electric drive under widely varying line and topographical conditions. Both gas turbines and motors find wide application with rotary compressors and centrifugal pumps, as such equipment is being developed for maximum line size and throughput.

today. The growing use of gas as a raw material in the petrochemical industry also adds greatly to its value.

The known gas reserves of the U. S., thousands of trillions of cubic feet, represent more available fuel, in British thermal unit content, than all of the known reserves of oil. The hundreds of gas repressuring and gas cycling operations emphasize the importance of the conservation of gas for later use. The demand for natural gas and the large amount of it available seem amply to warrant the extensive gas pipe line activity now evident.

When comparing the application of electric motors and gas turbines to pipe line service, it is recognized that electric motors and their supply and controlling systems are already well known and well established throughout all industry. Consideration only of their specific application to pipe-line drives is sufficient in this paper.

On the other hand, the gas turbine is relatively new in industry in America. A review of its salient characteristics and operating features, and its predictable position in industry is warranted. With this background, the application of gas turbines as pipe line compressor drives and a comparison with electric motors can better be considered.

Gas Turbine Systems

The gas turbine itself is a simple gas expansion turbine having a few number of stages, and running at a high speed. It derives energy by expanding gas from a high temperature and pressure to a lower temperature and discharge pressure. Its success rests on the extensive background of high temperature, steam turbine experience, and on the advances made in high temperature alloys.

The term "gas turbine" as discussed here includes the complete power unit from the fuel supply line to the output driving shaft. This includes the turbine, combustion equipment, air compressors, gears, and all auxiliaries. It also includes the heat regenerators and the air intercoolers in those more complex cycle systems in which such exchangers are used.

A wide variety of heat cycles is feasible for gas turbine power systems. These vary from the simplest "straight through" cycle to the more complex cycles having heat regeneration and compressor interstage cooling. The "in between" cycles are step-by-step variations having successively more of the features of the most complex cycle.

In general, as the heat cycle becomes more complex, the thermal efficiency increases, while the weight and space requirements, and therefore the cost, also increase. Thus the application and location will determine the best heat

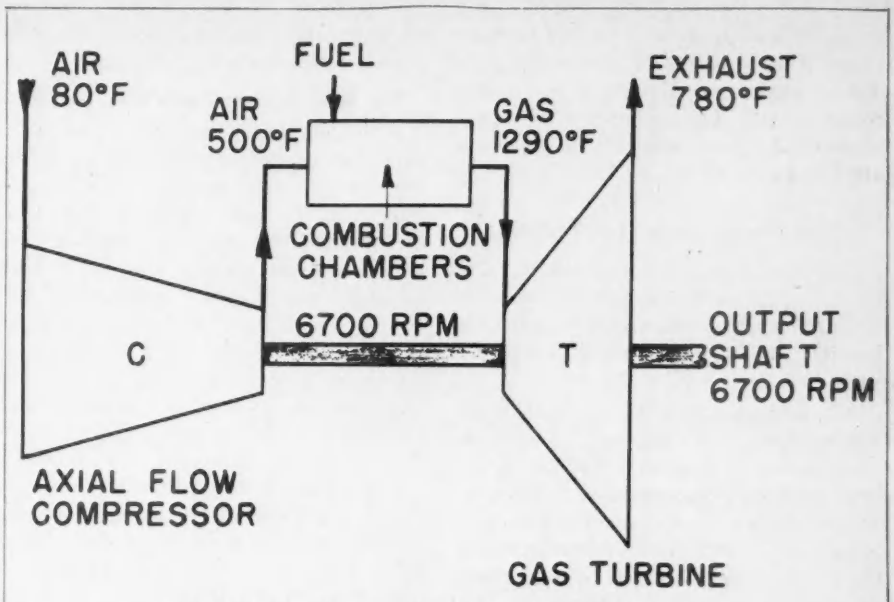

FIGURE 1. Flow diagram of a simple cycle gas-turbine system.

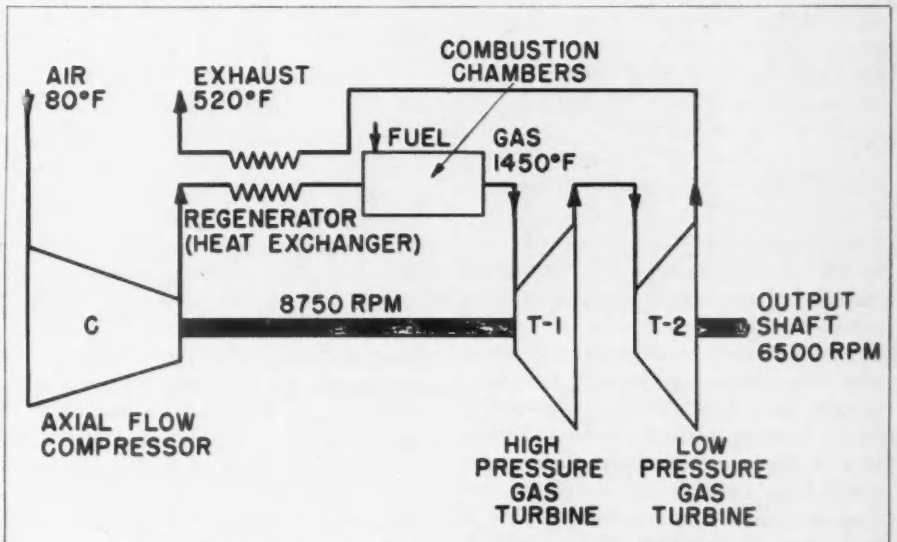

FIGURE 2. Flow diagram of a gas-turbine system with heat regenerator.

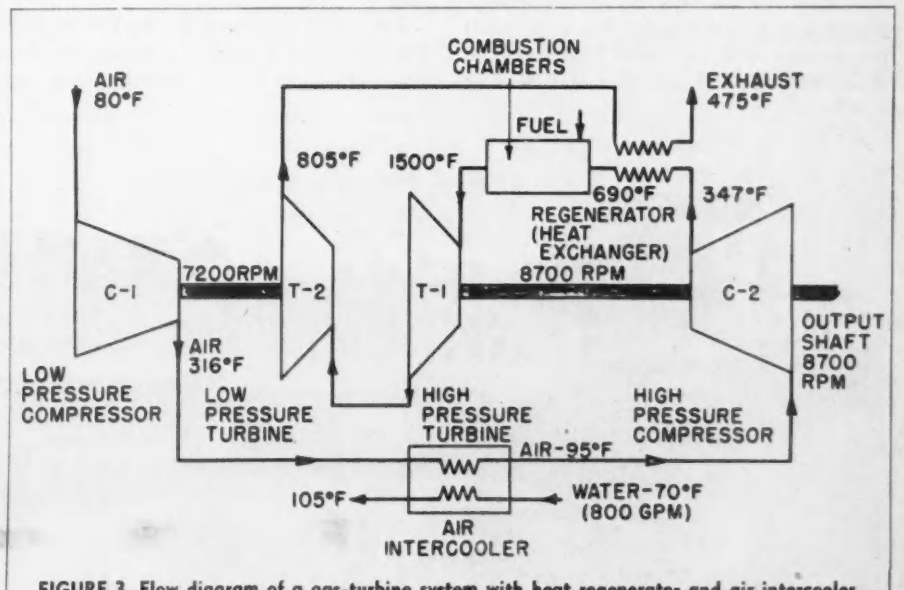

FIGURE 3. Flow diagram of a gas-turbine system with heat regenerator and air intercooler.

cycle. It is a question of proper balance between first cost and operating cost, and of evaluation of weight and space requirements. The principles of operation of the basic gas turbine elements are similar in all the cycles.

The Simple Cycle Gas Turbine

The flow diagram for a gas turbine power plant of the simplest "straight-through" cycle is shown in Figure 1. It has all its basic rotating parts on a single shaft.

Air is compressed in the axial flow compressor from atmosphere to six atmospheres and delivered to six duplicate cylindrical combustion chambers. Fuel oil or gas is injected into the combustion chambers where virtually complete combustion takes place to produce the hot gas mixture for delivery to the gas turbine itself. The two-stage turbine drives the air compressor, and the excess energy is available at the output load shaft on the end opposite the air compressor. Such a unit is very light and compact, has no heat exchanger or compressor intercooler equipment, and requires no cooling water. The entire volume of exhaust gas has a temperature of 780° F. The thermal efficiency is about 17 percent.

Before more efficient gas turbine heat cycles are considered, two important features of the simple cycle should be noted. First, the lower efficiency is not due to inefficient or incomplete combustion. Combustion is virtually complete; in fact, there is an excess of free oxygen in the hot gas mixture entering the turbine in all the practical gas turbine systems. But, to maintain simplicity and compactness, no provisions are made to make use of the heat of the 780° F. exhaust gas.

Secondly, the air is compressed all the way to the combustion chamber pressure in a multi-stage, but single unit compressor with no interstage cooling. No advantage is taken of water cooling to reduce the power required in the compression phase of the cycle.

The Intermediate Cycle Gas Turbine

Although many variations are possible, one practical form of an intermediate cycle system is that shown in Figure 2. Its basic feature is that heat exchangers, termed regenerators, are added to make use of some of the heat of the exhaust gas. Compressed air, from a single unit compressor, just as used in the simple cycle, is now preheated in the regenerators before combustion. The hot gas expands first through a high pressure turbine, which drives only the air compressor, and then through a low-pressure turbine which drives the load. The exhaust gas, after passing through the heat regenerator of this cycle, now has a temperature of 520° F. This is 260° F. lower than for the simple cycle, and the thermal efficiency has been increased to about 25 percent. This is a large gain for the cost and space requirements represented by the regenerators.

Features of the Two-Shaft Arrangement

In the flow diagram for the intermediate cycle, a two-shaft, rather than a single-shaft machine arrangement is shown. The load driving turbine is on a separate shaft and hence free to rotate at a speed different from that of the air compressor.

This is not done because of the addition of the regenerator. The same regenerator may be added to the single shaft unit, by a rearrangement of ducts and housings, and thereby effect the same gain in efficiency.

The two-shaft arrangement is to gain flexibility of operation for wider industrial service. Since the compressor and load shafts may rotate at different speeds two advantages for wider general service result.

First, the load speed may be lowered from maximum, within a reasonable design range, without reducing the air supply necessary to support the load at that speed. This is a distinct advantage, for example, for pipe line-gas compressors operating in series, where speeds and pressure ratios are varied to meet changing pipe line conditions.

The second advantage stems from the fact that, for a given design and shaft load, approximately a fixed weight and not volume of air is required. But, the specific weight of the intake air becomes less as its ambient temperature rises, and so the compressor needs to run at a higher speed to supply enough weight of air for the power required. With the compressor on a separate shaft its speed can be increased, as ambient air temperature rises, without affecting load speed. Likewise, the compressor speed can be decreased when the load demand decreases on a constant speed load such as that of an alternating current generator. Better partial load economy and more flexible control result.

This same feature permits duplicate designs to operate with comparable performance in different locations having different altitudes. The two-shaft arrangement answers many application problems.

The Complex Cycle Gas Turbine

In both the simple cycle and intermediate cycle systems considered, no cooling water is required. Therefore, they seem most applicable in oil field plants and pumping stations, especially in water scarce areas. However where cooling water is available the further refinement of compressor interstage cooling is justified.

A practical form of a complex cycle gas turbine power plant, having both heat regeneration and interstage cooling, is illustrated in Figure 3. This also is a two-shaft arrangement. On one shaft there is a low pressure, or first unit air compressor and a low pressure turbine to drive it. On the other shaft there is a high pressure gas turbine, with which

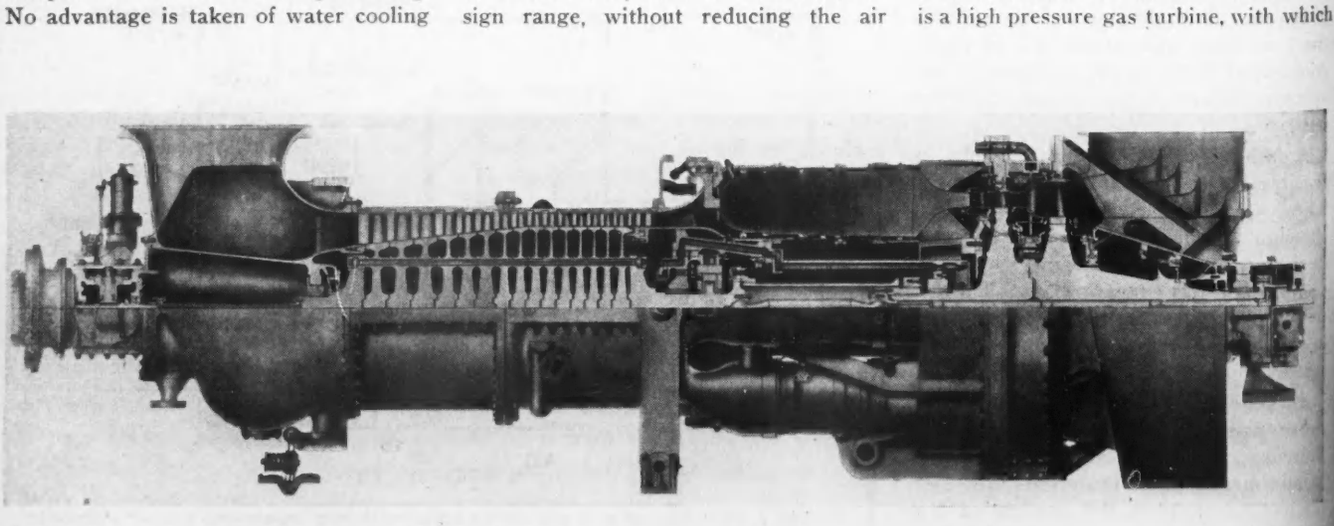

FIGURE 4. Gas-turbine for 4800-horsepower locomotive drive. Shaded longitudinal semisection.

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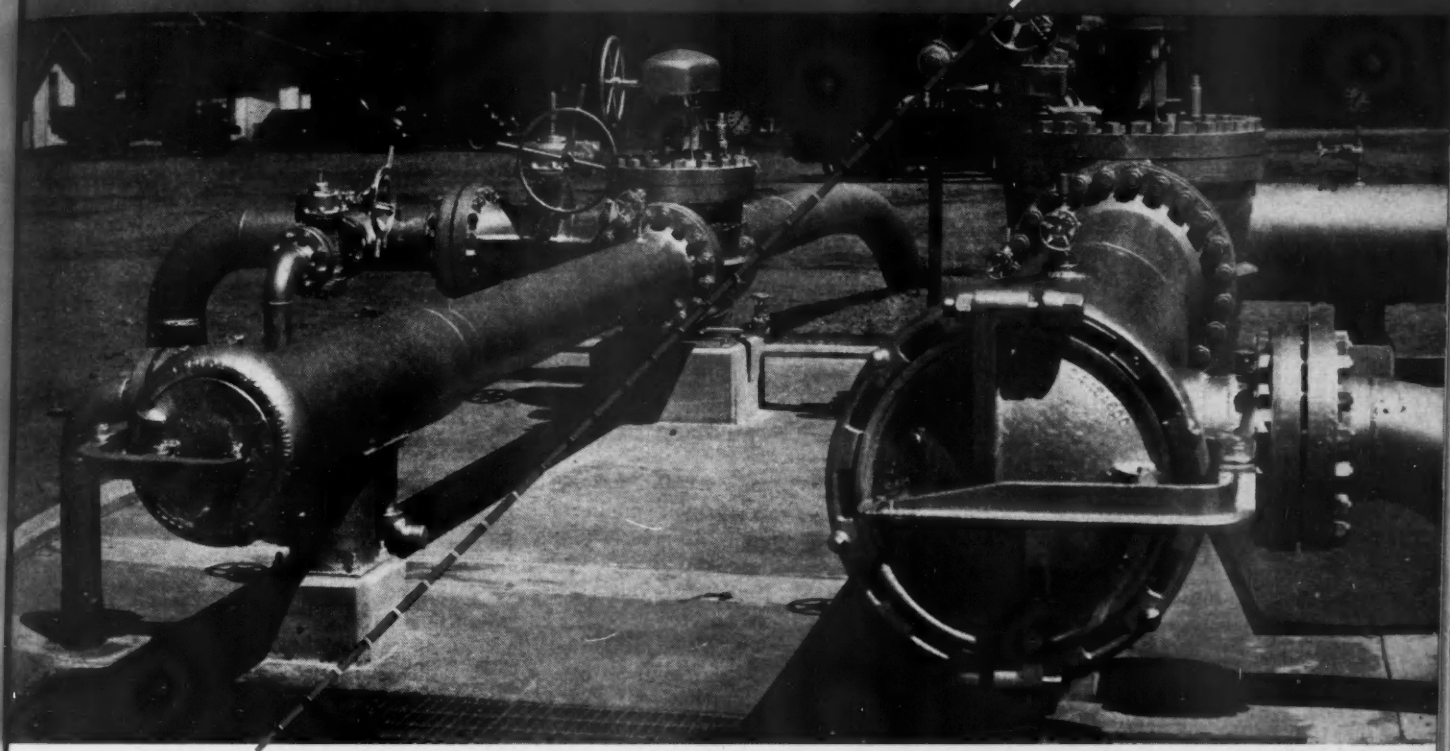

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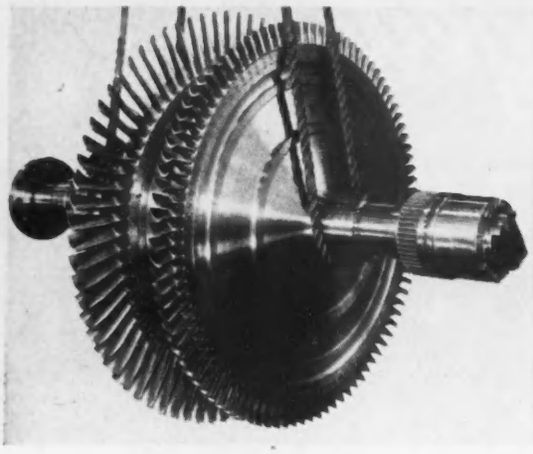

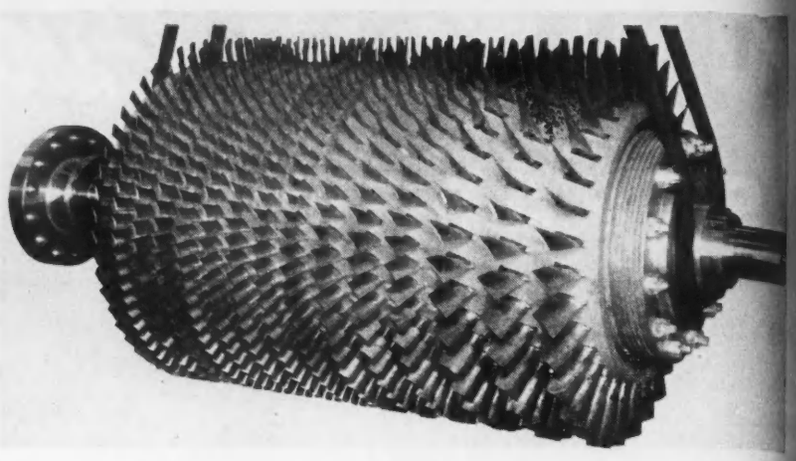

FIGURE 5 (Left). Gas-turbine power plant for 4800-horsepower locomotive drive. Complete assembly of turbine rotor. Oblique front view.

FIGURE 6 (Right). Gas-turbine power plant for 4800-horsepower locomotive drive. Complete assembly of compressor rotor.

drives the high pressure, or second unit air compressor, and also drives the load.

After compression to about three atmospheres in the first unit compressor, the air is cooled from 316° down to 95° F. before final compression to six atmospheres in the second unit compressor. From the combustion chambers the hot gas flows successively through the high pressure and low pressure turbines, and then through the regenerator to discharge. The exhaust gas temperature is 475° F., about 45° F. below that of the intermediate cycle, and the thermal efficiency has been raised to approximately 30 percent. This is comparable with the best industrial power plants available in the sizes involved. For a typical 7000-hp unit the intercoolers require about 800 gallons per minute of water on a basis of a 35° F. rise.

Many minor variations of heat cycles are possible. But the typical simple, intermediate, and complex examples considered here illustrate the principles involved. They, or their close equivalents are the ones which most likely will find the more practical applications in industry.

Before considering the practical applications of these various cycle systems, a view of the machines and a brief explanation of their essential auxiliaries is of interest.

Gas Turbine Construction and Functions of Auxiliaries

A cut away section of a simple cycle, single-shaft gas turbine is shown in Figure 4. From left-to-right there are the governing mechanism, the air intake manifold, the axial flow compressor, the combustion chambers, the gas turbine itself, and the exhaust manifold. Figure 5 is a view of the turbine rotor, and Figure 6 one of the air compressor rotor. Figure 7 of the combustion chamber liners illustrates their light weight and simplicity. These parts can be replaced on an entire assembly in less than an hour.

The gas turbine, so far, has been designed to use diesel oil, bunker-C, and gas. When supplied to run on bunker-C, facilities are provided to start on diesel oil, and to switch to bunker-C as soon as the turbine comes up to idling speed. Diesel oil is also used at the shutdown of any run in order to purge the system for the next start.

Only slight modifications in the combustors and fuel nozzles are required to burn gas. The gas fuel system is simpler, and it requires no separate starting fuel facilities or storage. Fuel pumps and injectors are included with the oil burning plants, and fuel gas regulators for the gas burning plants.

Speed control is obtained by varying the amount of fuel admitted. There are no valves between the combustion chambers and the turbine itself.

The governor is gear-driven from the shaft. It has a separate electrical power source and controls the fuel regulating valves. It can be remotely preset over the design speed range, and hence can be readily applied to any conventional automatically regulated system.

An emergency overspeed governor will close the fuel shutoff valves at 110 percent of maximum operating speed.

Since the gas turbine is a prime-mover, operating directly from a fuel source, it must have auxiliary means for starting. A wound rotor induction motor is geared to the shaft, through an overrunning clutch, to bring the unit to about 60 percent speed. At this speed enough air is compressed to permit the turbine to come up to full speed by itself. Firing takes place at about 10 percent speed during the starting cycle. For a 5000-hp turbine a starting motor of about 200 hp is required. The electric power required is available in many applications. Where it is not, an engine generator is required. It can usually be arranged that this engine generator is also the station service standby.

The lubricating oil requirements are limited to those for bearings and gears. An integral, closed cycle lube oil system is used. It includes a shaft driven centrifugal oil pump, an oil storage tank with coolers, and an air heat exchanger, as well as motor driven "start-up" and "coast-down" auxiliary oil pumps.

The other accessories include: the fuel ignition system, a governor control and power supply set, and the necessary pressure, temperature, speed, and vibration instruments.

The gas turbine can be brought from a cold shutdown to full operation in a matter of minutes.

Applications of Simple Cycle Gas Turbines

Although the chief consideration here is the application of gas turbines to pipe line service, important possible uses in other phases of the petroleum industry point to wider general usage which will increase the availability of gas turbine drives at more attractive costs. Plants of all three basic heat cycles are being seriously studied by all industry, and many are now being built.

The simple cycle, single shaft unit, already referred to in Figure 4, was specifically designed as a railway locomotive power plant. One is now in regular road service, in a single cab, 4800-hp, turbine-electric locomotive. Early reports of its performance are very encouraging.

An important group of applications for simple cycle gas turbines is based on the large amount of "waste" heat recoverable from the exhaust gas. In processes where by-process heat or steam is required, low pressure, waste-

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heat boilers or heat exchangers can be used effectively. Then the net thermal efficiency of the over-all system is quite high even though that of the gas turbine itself is relatively low.

This principle seems thoroughly practical, for example, for a natural gasoline plant with gas turbine generators serving plant electric power and the exhaust gas producing process steam for the distillation plant, or to be used to preheat the absorption oil.

Careful physical layouts will be necessary to locate properly the turbine, heat exchangers, and duct work for safe operation. Also, a good balance between heat required in process and heat available must be arranged. But the gains can be large.

Briefly summarized, simple-cycle gas turbines have wide application:

1. Where the great saving in weight and space, compared to any other available prime mover, outweighs the higher fuel consumption.
2. Where effective use of the waste heat can be made to increase materially the over-all thermal efficiency.
3. Where large quantities of low British thermal unit gases can not be used effectively by other available means.

Applications of the Intermediate and Complex Cycle Gas Turbines

The intermediate and complex cycle gas turbines will find wide application for all types of stationary industrial drives where no by-process heat is required.

By omitting the alternating current generator and choosing the correct ratio for the gear to the output shaft, such a plant can be used to drive fans, blowers, pumps and compressors at any speed best suited to the design in each case. Therefore, optimum designs, both for the gas turbines and the driven machines, can be established and yet permit a wide field of use.

The size of the regenerators is appreciable, but the plant is still compact for a unit of this rating and efficiency.

Gas pipe line pumping stations are in this broad field of industrial use. Complex cycle equipment should prove more economical where cooling water is readily available, and intermediate cycle equipments in water scarce areas. The types may be mixed, from station-to-station, and chosen on the basis of local water conditions in each case.

Gas Turbine Compressors for Gas Pipe Lines

For large gas pipe line stations, not only are big advantages possible by the use of high speed, turbine-driven compressors, but even further gains are offered by the use of a few units, each of as large a rating as feasible. Centrifugal compressors, ideally suited to high volume, low pressure ratio service, are now practical in ratings up to 7000 hp. There seems to be no technical limit to even larger compressors.

With the gas compressors in series, and driven by 5000-hp gas turbines, pumping stations of 10,000 hp, 15,000 hp, and 20,000 hp would require only two, three, and four units respectively. Speed control for flexibility of operation, and practical quick starting means are available.

A preliminary, but carefully studied 15,000-hp station layout for three 5000-hp units, complete with all auxiliary and station services, indicates that a building only 60 by 60 feet is sufficient. And the building is a simple, single floor structure with a flat pad floor. Only the intake air and exhaust stacks are outside.

The really significant first-cost figures for gas turbine compressors will be those which represent the total station installed costs. As for all new things, they are not yet available, but estimates are highly encouraging. Detailed planned cost will emerge before long.

The apparatus costs themselves for gas turbine compressors, complete with all auxiliaries and accessories, except for building services, are approximately $75, $85, and $100 per horsepower respectively for the simple, intermediate, and complex cycle equipments in the 5000 to 7000 hp units which have been considered here.

Installed costs will reflect the advantages of lower space and weight requirements and of the use of fewer, higher rated units. They also will permit evaluation of the simplicity of foundations, and of the lower service requirements for cooling water, auxiliaries, and maintenance facilities.

Where only gas or oil is available as a source of power in industry, the gas turbine has its greatest possible field. Where by-process heat is required, it is already proving itself, and where "waste" fuel gases are available, doubtless there will be good applications to come.

Choice of Motors and Station Arrangement for Pipe Line Drives

Where there is a choice between power derived directly from fuels, or from purchased electric energy, there are many factors which warrant careful consideration of electric motors for pipe line drives. These factors are of importance only as they affect over-all operating costs, but they include much more than a mere comparison between fuel and power costs.

Installed electric station costs are the lowest of those for any type of available drives. This is due not only to the low equipment cost, but also to the low space and weight requirements. No cooling water is required, and the auxiliaries and accessories are few and simple.

Other than the motor compressors themselves, the main apparatus consists of the step down substation, the control switchgear, and the valve and piping system.

The motors for crude oil and gas pipe lines are invariably squirrel cage induction motors. Since the viscosity is nearly constant in each case, the power and speed of the pumps or compressors can

FIGURE 7. Combustion equipment, including outer casing, fuel nozzle, transition piece, and inner liner, for gas-turbine for 4800-horsepower locomotive drive.

be constant for normal operating conditions of full throughput.

Normally all units on the line are operated and the availability is high. When any unit is out of serivce some reduction in throughput is accepted. Line pressure conditions are balanced to near normal by throttling the flow, and, also when necessary, by shutting down other units in the upstream and downstream stations until all units can be returned to normal service. Such a method for dealing with emergency conditions is practical and economical.

For product pipe lines for which the viscosity changes are appreciable, from product to product, ideally a pump speed of 15 percent below maximum is desired for several months of the year. Wound rotor motors with automatic slip regulators provide the best motor application. Several product lines are so equipped, and others are being considered.

Nevertheless many product lines are equipped with squirrel cage motors and all control is obtained by throttling.

For all types of pipe lines the presence of gas or oil creates a potential hazard. Several types of motor and building construction to meet this condition are in use, among them:

a) Explosion-proof motors, close-coupled to the pumps in the pump room. In this case, all accessory equipment including lighting in the pump room must also be explosion proof.

b) Standard dripproof motors, in a separately ventilated motor room, driving pumps through pressurized shaft seals in a fire wall which separates the pump and motor rooms.

c) Forced air, duct ventilated motors, close-coupled to the pumps in the pump room, with explosion-proof pump room accessories.

d) Forced air, duct ventilated motors, in a separate motor room, driving pumps through a fire wall.

The last arrangement has many practical advantages and is coming into wide use. A ventilating system of approximately the same output and complexity is required for any arrangement. With duct ventilated motors the air can be drawn from a high or remote safe area, thereby affording cooling and non-hazardous atmosphere at the lowest cost. By the use of a fire wall, the motor room can also include the switchgear, control and building service equipment. A small amount of the ventilating air is used to pressurize the motor room and permit the use of standard indoor equipment.

A comparable arrangement for gas turbine driven compressors is practical. It includes intake and exhaust ducts to the turbine, a fire wall between the gear assembly and the compressor, and a ventilated turbine room also containing the standard accessory and control equipment.

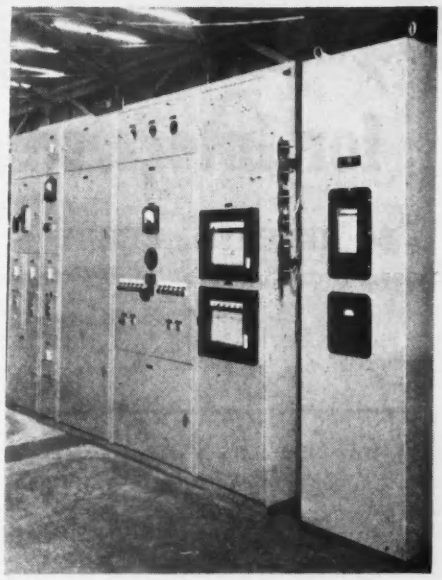


FIGURE 8. Control station of 3500-kilowatt gas-turbine generator set on test stand.

Maximum Ratings of Motors for Pipe Line Drives

As noted before, rotary pumps and compressors of large volume, low pressure ratio designs are being made available in ratings as large as are applicable; therefore, for motors also it is desirable to provide as few units, each of as large a rating as other considerations will permit.

Two important factors determine the maximum motor size in practice. First is the problem of starting: If motors are too large, the power lines and substations are unduly expensive to avoid excessive voltage disturbances during starting periods.

In practice it has been found that 2000-hp motors are thoroughly practical in this respect on any power systems which are capable of supplying large pumping stations such as are involved for gas pipe lines. But, even larger motors, up to 5000 hp, should be practical from a starting standpoint in many cases.

The other factor affecting the size of each unit is the problem of operating flexibility. Since the motors run at constant speed, there need to be enough units per station to permit adequate control by simply starting and stopping units as required, in order to minimize the throttling required under emergency operations.

For large installations, three 2000-hp compressors in series in each of two parallel "banks" provide a total station capacity of 12,000 hp. Operating experience shows that six units do provide adequate flexibility when the up-stream and down-stream stations are likewise arranged. It can be seen that by choosing 1500, 2000 or 2500-hp motors in either six-unit, or eight-unit stations, a range of from 9000 to 20,000 hp is readily available.

Operating Advantages of Motor Drives

Not only is the installed first cost for motor-driven stations low, but also are the maintenance and operating costs. Maintenance on motors, transformers, and switchgear is the lowest of any motive equipment known. Lubricating requirements are slight, and no cooling water facilities are needed.

Because of simplicity and high availability, the operating and maintenance personnel is at a minimum, even in attended stations.

One of the most promising developments now gaining active interest is that of remote supervised, unattended pumping stations. With motor-driven stations, this should be highly practical and economical. It will be an adaptation of equipment and methods which have already been widely used in similar services.

Wire circuits over telephone lines or by carrier over power lines are used when available, and radio beam transmission where they are not. With such systems, it is practical to plan master supervisor's stations at intervals along the pipe line, and use unattended supervised stations for all intervening points.

With the many distinct installed cost and operating-cost advantages which motor drives offer, their use warrants more careful over-all cost studies for locations wherever electric power can be made available. As more pipe lines expand into more heavily populated industrial areas, the trend toward electric drives will increase.

Both types of drives considered, motors and gas turbines, are highly applicable to rotary pumps and compressors which are sure to expand in use for pipe line service. Motors should prove to be more economical wherever electric power is available at favorable rates.

The gas turbine is a fine new tool wherever power is to be derived directly from fuels, and where the unit rating warrants its application.

Since a long pipe line spans such distances that conditions change radically with respect to fuel and power, it is logical to change the types of drives along the line to suit these conditions. For instance, for gas pipe lines the use of gas turbines near the sending end and motors near the delivery end is receiving serious consideration, and is as practical as it is logical.

Closed System Layout for Intermediate Station

By HUBERT L. DRAKE
Engineer, Stanolind Pipe Line Company

THE AUTHOR outlines a plan whereby a tank is provided for emergency relief while plunger-type pumps, of multiple-cylinder design, provide normal throughput without use of over-and-short gauging and consequent possibility of contamination or down-grading of product through comingling when a batch interface passes the tank tie-in.

PIPE line engineers have long realized that it is economically desirable to use as few storage tanks as possible while moving crude oil or its products from field or refinery to final destination. Tanks are expensive to build and maintain and tank life is shortened considerably when handling corrosive oils. Furthermore, the storing of oil or refined products in tanks results in certain evaporation losses which are reflected in smaller earnings to the company. Then there are greater possibilities of mixing oil when handling various grades of crude or refined products in the same line. This results in the down-grading of some oil, and this again represents a loss to the operator.

It is not always possible to handle oil through a station without tanks. This is usually due to different rates of flow coming in or going out of a station resulting from batching operations or deliveries to some branch location. The type of pumping equipment used also affects the ease of pumping oil as a "closed system." A series of stations on a line using centrifugal pumps and electric drives make the problem somewhat easier. Older pumping equipment and internal combustion engines driving reciprocal pumps are a little more difficult.

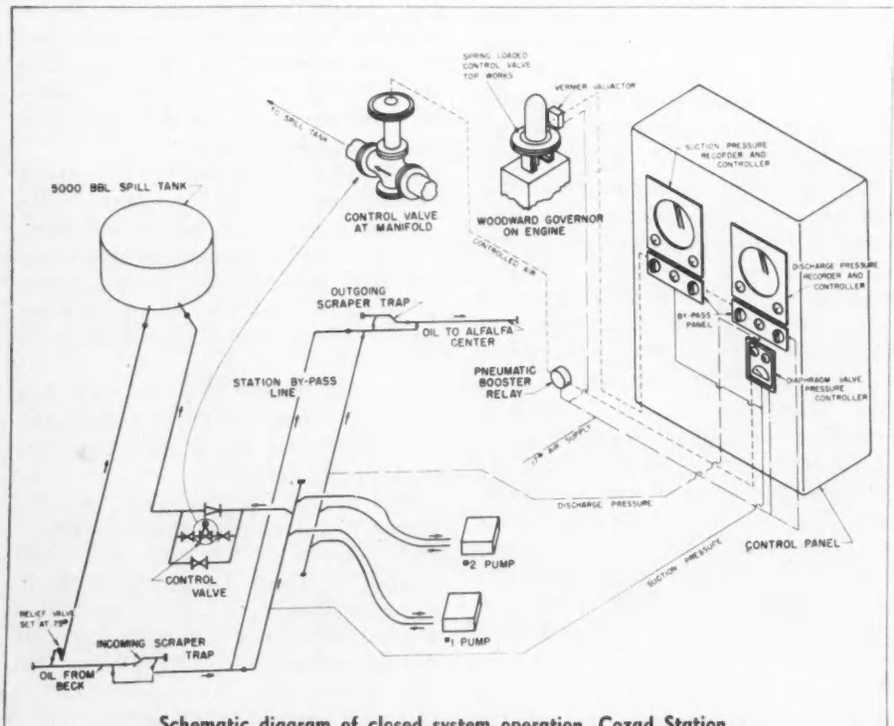
Station Offers Possibilities

Stanolind Pipe Line Company's Cozad Station on the Casper-Freeman Line offered possibilities for closed system operation. Pumping equipment for this station consists of two 780-horsepower dual-fuel engines running at 375 revolutions per minute directly coupled to two 10-cylinder pumps each having four-inch stroke. Each unit is capable of pumping 2200 barrels per hour at 710 pounds pressure. As this station relays only the oil being received, closed system operation was planned. This consists simply of the necessary automatic air-operated controls to adjust the engine speed so that the pumps will handle exactly the amount of oil being received while holding sufficient back-pressure on the suction side to make them fill properly.

The incoming oil stream comes into the manifold into a header to which the suction from each pump is tied. An air-operated control valve is also connected to this header. The other side of the control valve connects to a 5000-barrel emergency spill tank. A quarter-inch air line connects from the top of the control valve into the station building to an air-operated pressure controller. This is nothing more than an air regulator valve fed by a source of 17-pound dry air whereby the outside oil control valve can be set to open at any pressure up to 75 pounds. About 45 pounds are being used at the Cozad Station for the control valve setting.

At this stage the oil is coming into the pumps, from the station below at 45 pounds pressure. If the pressure should exceed 45 pounds the oil would go into the emergency spill tank. The next step is to get the engines to operate at such speed that the pumps will fill properly and not put any oil into the spill tank. This is done by the use of a half-inch line from the suction header in the manifold to a suction controller on the instrument panel. This same line also branch connects to the control valve pressure controller.

In like manner a half-inch line is brought in from the discharge header in the manifold to a discharge controller on the instrument panel. From the discharge controller a line connects to the vernier valvactor on the engine governor. The suction controller and the discharge controller are also connected. The suction and discharge con-



Schematic diagram of closed system operation, Cozad Station.

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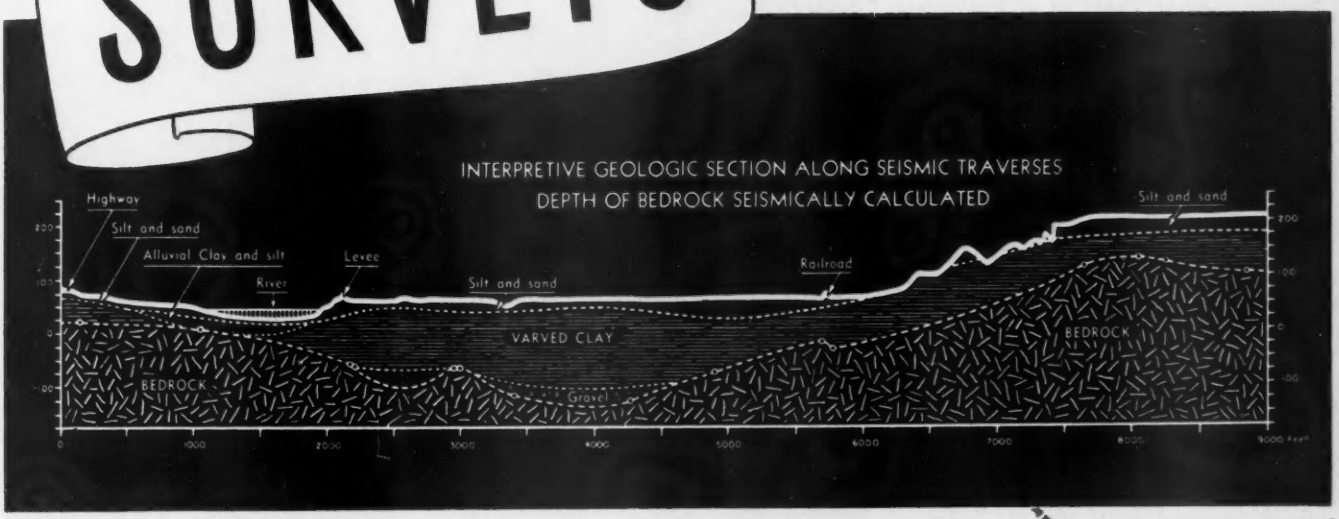

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troller have index setting knobs whereby one can adjust for whatever pressure is wanted for the controller to take over the control of the engine speed.

Cozad Station uses about 15 pounds setting on the suction controller and 650 pounds on the discharge controller. If the amount of oil coming into Cozad decreases, the suction controller will take over and slow the engine down maintaining 15 pounds suction on the pump. If the incoming stream should increase, the suction controller would cause the engine to speed up still maintaining 15 pounds suction on the pump. If for any reason the station discharge pressure should increase to the index setting, the discharge controller will take over the engine speed control and slow the engine to hold the discharge pressure to the pressure set on the index.

Each controller also has a bypass panel whereby the engine speed control may be taken off automatic control and operated manually from the panel board. Instead of automatically controlling the air supply to the engine governor mechanism, it is done by adjusting a small air regulator valve by hand.

By using a pressure of around 15 pounds on the suction controller, this gives some leeway for the engine to vary the speed before the control valve would act to put oil into the tank.

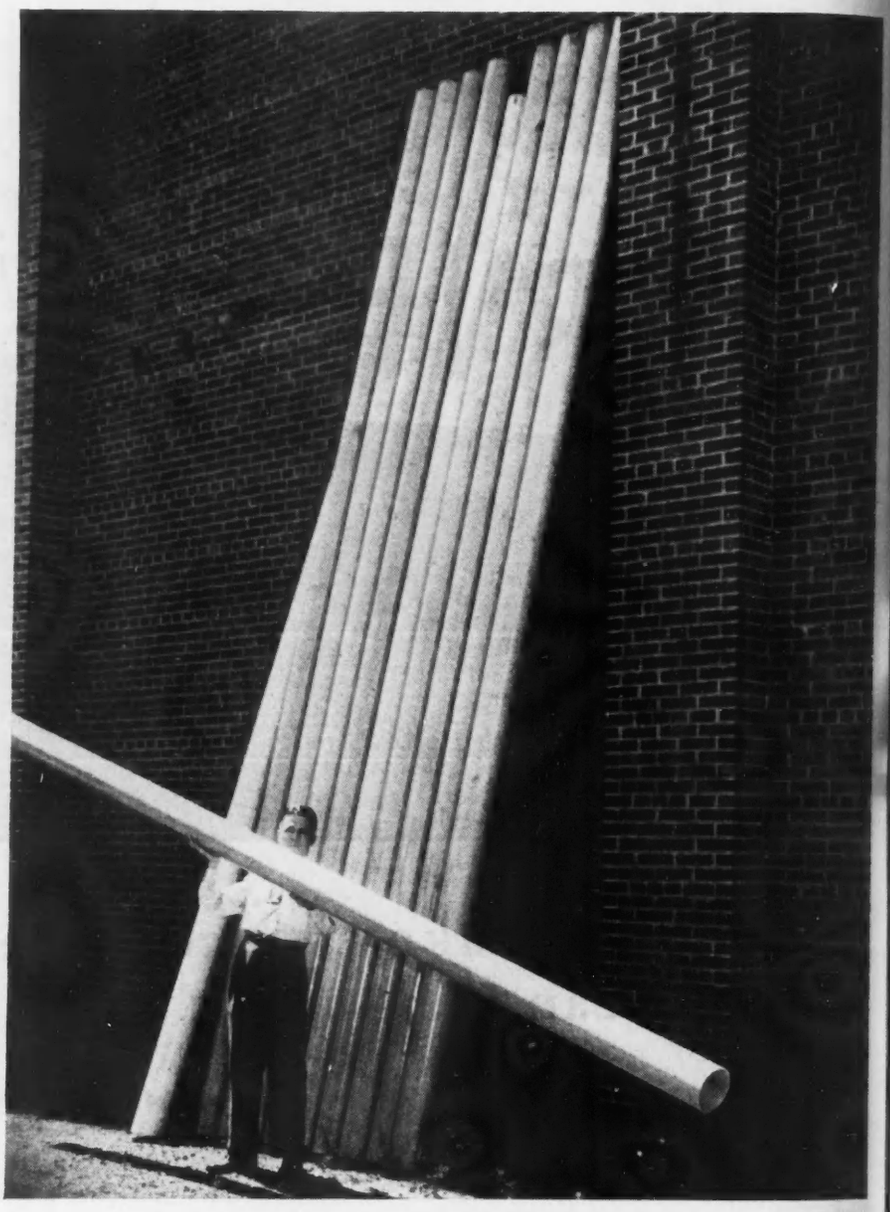
Alternate Adjustments

If the units should die for any reason or it becomes necessary to suddenly shut down, the station engineer has two alternatives. If the trouble is minor and the engine can be put back on the line in a few minutes, he can allow the stream to go into the tank, which it will do automatically. If the engine cannot be restarted soon he can open the station bypass valve, close the gate on the incoming stream and the gate under the incoming relief valve and allow the stream to bypass the station. He would first notify the station pumping to him as to what he was going to do in order for it to reduce pumping so as to prevent the discharge pressure from going too high. If communication could not be established with the station pumping to him he could close the incoming gate slowly, which would in turn build up the discharge pressure slowly at the station pumping to him. If the engineer at the up-stream station failed to detect the rise in his discharge pressure the relief valve on the unit would open and prevent the pressure from going higher.

Cozad Station started pumping oil early in 1949 and, as is usual with any new equipment installed, a few days were needed to make the proper adjustments on the instruments so that the station could "run even" with the incoming stream. After the station and the new equipment settled down, the greatest amount of oil that has gone into the spill tank has been eight feet or 1675 barrels.

The question may arise as to how the oil is removed from the 5000-barrel spill tank if this becomes necessary while the station is pumping. The station suction pump is connected up so that it can take suction on the tank and discharge into the main suction header in the manifold. This would have the same effect on the automatic engine controls as receiving more oil from the incoming stream. The suction controller would increase the engine speed enough to allow the main pump to handle the extra oil being drawn from the tank by the suction pump.

Glass Pipe for Army Engineers



Plastic-impregnated fiberglas fabric pipe, now undergoing tests at the Engineer Research and Development Laboratories, Fort Belvoir, Va., may replace steel in Army Combat cross-country fuel lines. Weighing only 45 pounds per 20-foot section as compared with 185 pounds for the steel counterpart, this pipe could be dropped in near-inaccessible locations by helicopter. Burst pressures as great as 1500 pounds per square inch have been recorded with test samples.

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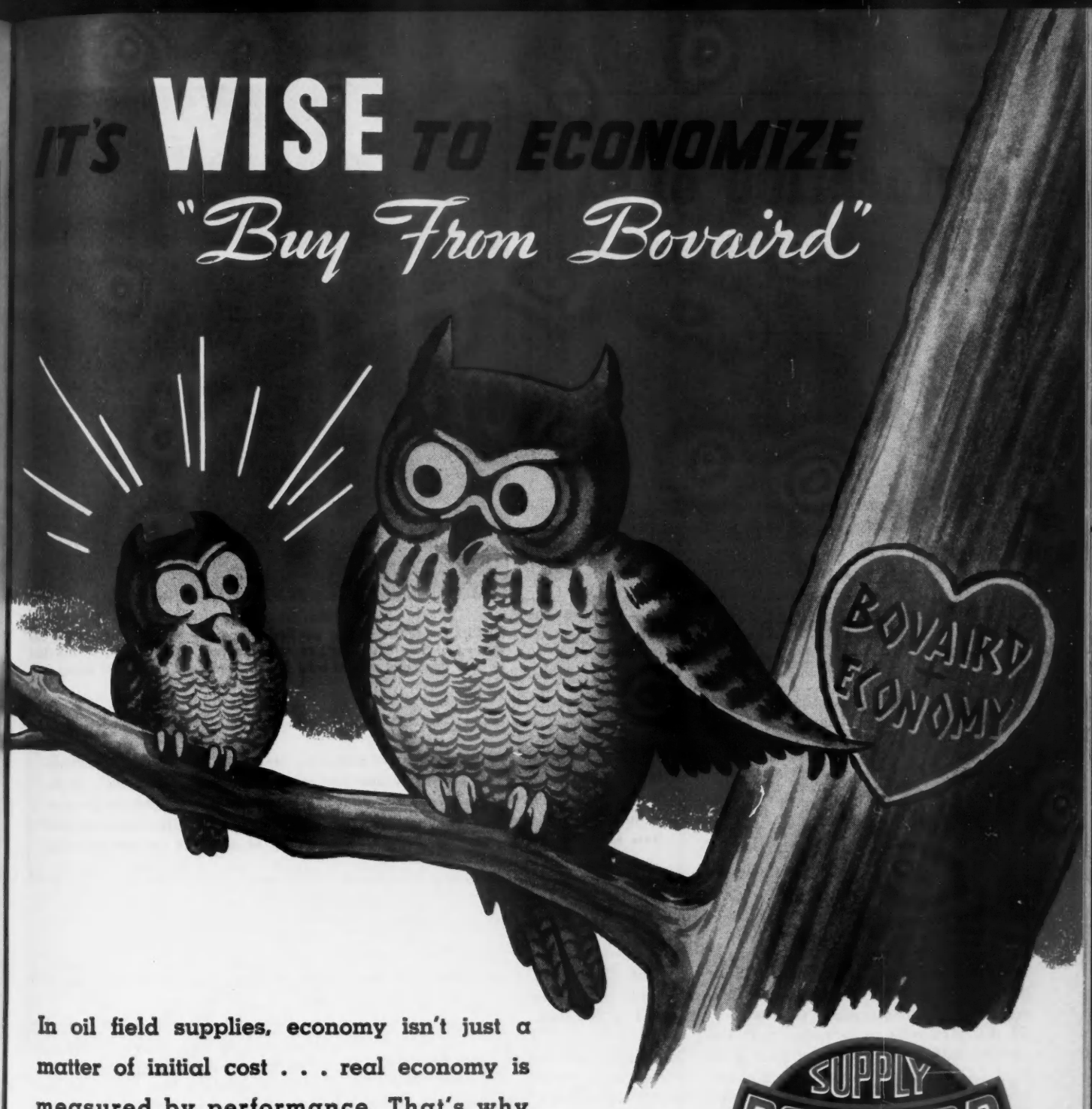

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Engineering of Pipe Line Anchors

By STARR THAYER
Consulting Engineer, Houston

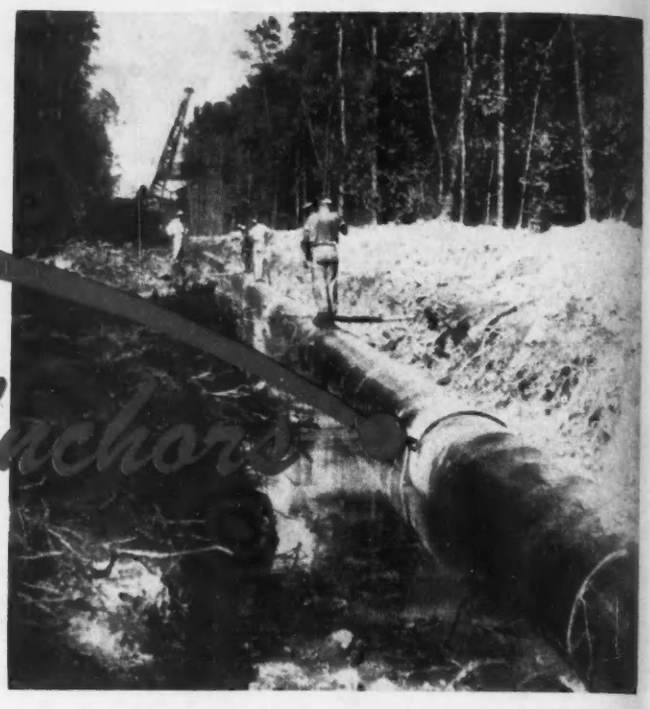


FIGURE 1. Large diameter gas line through swamp, showing saddles and spacing of hold-down units to resist buoyant effect of practically fluid silt deposited around pipe during conditions at time of laying.

THE NECESSITY for a positive means of anchoring pipe lines in permanent position, in areas where there is a possibility that they may rise due to the buoyancy of the line, is evident. With the advent of large diameter pipe lines and light-weight pipe to further challenge the pipe line engineer's ingenuity, the problem resolves into how best to do it. Presented here is a brief survey of past and current methods.

IN THE past, several methods have been used to hold lines in place. One crude method occasionally used was to fill the ditch with rocks rather than the earthen back-fill. This did not work well. Probably the most common method has been the placing of weights on the pipe before lowering it into the ditch.

A more recent development is the use of expanding anchors set well below the bottom of the ditch and using rods to connect the anchors to a saddle positioned on the pipe.

Weights or Gravity-Type Anchors

For many years, the most common pipe weights have been cast iron, in the form of semi-circular pairs bolted to the pipe line. These are known as river weights. To a limited extent only, concrete weights of similar design have been used.

In the use of these types, the individual unit as well as the spacing of the units on the line is determined, of course, by the buoyancy of the line. However, there is a limit to the weight of each unit; for example, a weight of more than 2500 pounds for each half would be very difficult to install.

There are several features in this type of anchor that may be considered undesirable.

1. They are heavy and often present a transportation problem.

2. They are not easy to install. The pipe coating under the anchor must not be damaged. This applies especially with the cast iron anchor.

3. They are expensive.

4. There is a possibility that in some types of marshes these anchors would cause the pipe to sink to undesired depths.

5. When the pipe is "snaked" into place after the anchors are installed on

TABLE 1

Effective Hold-Down Reaction of Pipe Line Anchor Installations Based on Field Tests in Various Types of Soil

Weight of Assembly	Wing Spread		TYPE OF SOIL			
			Clay or Hard Pan Pounds	Dry Sandy Pounds	Wet Loam Pounds	Very Poor Light Soil Pounds
80 lbs.	16″	.....	35,000	25,000	18,000	11,000
		*Cast Iron.....	41,000	29,000	21,000	13,000
		*Concrete.....	60,000	43,000	31,000	19,000
100 lbs.	21″	.....	63,000	42,000	34,000	22,000
		*Cast Iron.....	74,000	49,000	40,000	26,000
		*Concrete.....	108,000	72,000	58,000	38,000
120 lbs.	26″	.....	80,000	70,000	56,000	37,000
		*Cast Iron.....	94,000	82,000	66,000	43,000
		*Concrete.....	138,000	120,000	96,000	63,000

* Indicates equivalent weight of respective materials to obtain the same reaction or hold down, when submerged in water.

it, care must be taken to insure that pipe will not be buckled in the operation.

However, this type of anchor offers these advantages: it will not suffer from corrosion; and it can be placed on lines that are to be lowered into deep waters.

Expanding earth anchors are being utilized on many lines. Each assembly consists of two expanding anchors with their anchor rods, and a strong steel saddle to connect the rods to the pipe line (Figure 2).

These anchors are made in several sizes to accommodate the various line sizes and types of soil encountered. Also, the rods vary in diameter to give the necessary tensile strength. The lengths of the rods will vary, depending upon the "hold down" power necessary and the depth it is necessary to get a good holding soil.

In contrast to the weight type, these anchors are very light in weight and are relatively easy to install. In swampy areas, any type of motor transportation is often nearly impossible. One of these anchor assemblies, together with all of the tools necessary to install it, can easily be carried to the location by the men making the installation.

The method of making the installation is illustrated in Figure 3.

The tools required are few and simple for making any installation. They consist of an earth auger, a socket wrench with turning bar, and a crescent wrench. Compare this with the equipment necessary to set a 5000-pound river clamp in place, and the savings in installation costs are obvious.

An added advantage of this anchor over the weight type is that, if necessary at a future date, the anchor may be easily removed from the line.

There are few instances where limitations are placed on this anchor. One is where the line is to be laid in deep water. The other would be where it is impossible to find a soil to anchor to at any reasonable depth below the line.

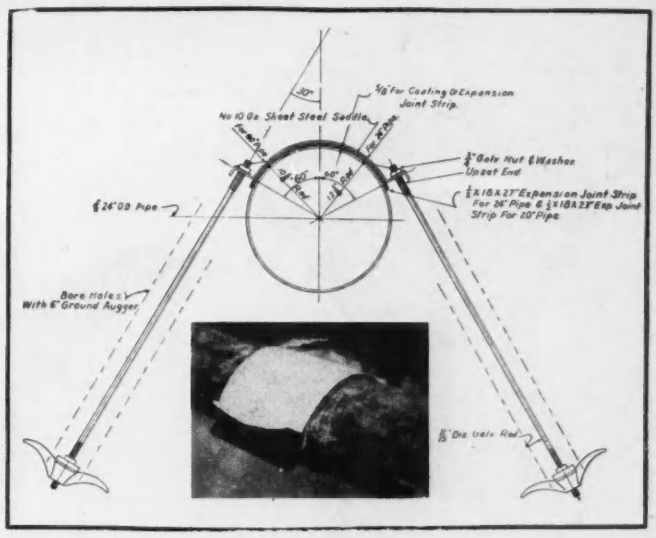


FIGURE 2. Schematic sketch of anchor and method of placing on pipe. Dimensions shown apply to 24-inch pipe.

Table 1 shows the effective reaction of two different sizes of anchors in various types of soil. These data have been obtained by field tests. The tabulation also shows the equivalent amount of weights in iron and concrete that would be necessary to furnish the same anchorage as this saddle and expanding anchor assembly.

These are not the only sizes available. However, the above clearly demonstrates the advantages of this anchor when considering the weights of the two systems. As an example, an anchor weighing but 200 pounds complete, when set in hard pan, has the same anchorage value as 138,000 pounds of concrete or 94,000 pounds of iron.

Anchors in Hilly Terrain

Pipe lines laid on steep slopes develop stresses which are often neglected, but which should be considered. Naturally there is a downhill thrust on such a line. The following table shows what these thrusts are in percent of the weight of the pipe and at different degrees of slope.

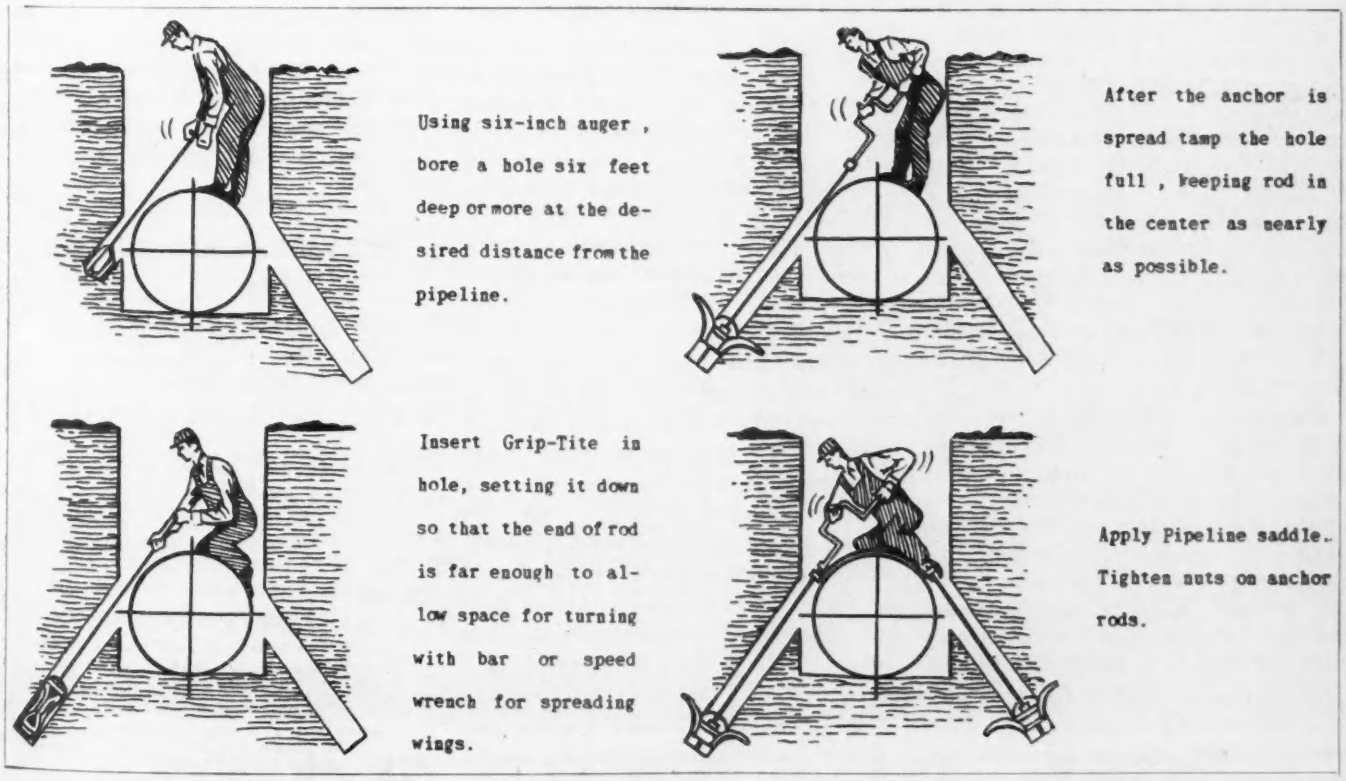

Using six-inch auger, bore a hole six feet deep or more at the desired distance from the pipeline.
After the anchor is spread tamp the hole full, keeping rod in the center as nearly as possible.
Insert Grip-Tite in hole, setting it down so that the end of rod is far enough to allow space for turning with bar or speed wrench for spreading wings.
Apply Pipeline saddle. Tighten nuts on anchor rods.

FIGURE 3

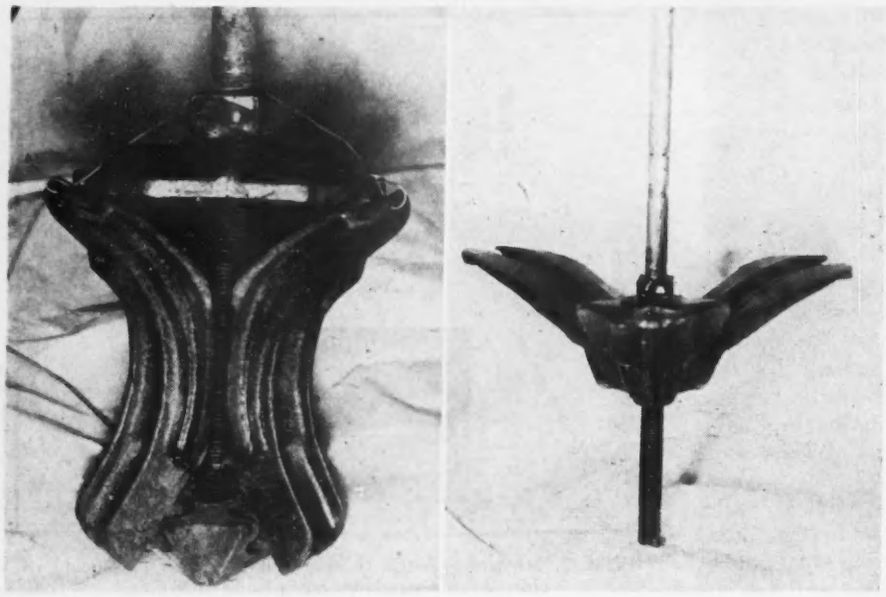


FIGURE 4. Left: Typical hold-down unit in closed or shipping position. The three spuds enclose and protect thread. Right: The anchor in service position, with three prongs fully extended by action of screw in special spreader nut.

Angle of Slope in Degrees	Net Thrust in Percent of Pipe Weight
20	0
30	18.5
45	45
60	68.4

Figure 5 shows the resolution of forces.

It will be noted that the downhill thrust is offset by the friction between pipe and earth on slopes up to 20 degrees.

On a slope of 30 degrees, for example, a section of pipe weighing 100 tons would have a thrust of 18.5 tons. These thrusts may or may not be serious enough to consider, depending upon several factors, such as weight of line, length of slope, etc. However, if the thrusts are of such magnitude that they should be withheld, these anchors, properly spaced, should be found of value. The regular earth type of anchor will serve. However, in many such locations there is nothing but rock, and a special rock anchor has been perfected for this purpose. The reactive force developed by this anchor is limited only by the strength of the rock in which it is installed.

Some engineers include the weight of the backfill in computing the anchorage necessary to hold down a pipe line. It is true that the backfill in some soils does furnish considerable anchorage. In fact, many lines laid in rice fields, anchored only with the backfill, have never given any trouble. However, there are also instances where, under similar conditions, the lines have risen to the surface.

It is quite possible that over a considerable period of flooding, a soil could become totally saturated. In such a condition, the backfill would be converted to a slurry of mud and water, having a density of possibly 80 to 100 pounds per cubic foot. The buoyancy of the line is known. From the above, it would be a simple matter to compute the anchors that would be necessary. It must be considered, however, that all of the backfill weight is not effective due to the curvature of the pipe.

Probably the safest construction in such instances would be to neglect totally the weight of the backfill, which in itself is not a definite and known factor.

Expanding Anchors Under Water

The installation of expanding anchors under water presents new problems. It is readily seen that in some instances such installations could become excessive in cost. For instance, if the bottom of the body of water consisted of nothing but silt for a considerable depth, these anchors could not be used. A very rapidly moving stream could present difficulties.

There are many under-water crossings, however, where it is possible, as well as economical, to use these anchors. When working from a light weight barge, a diver should be able to install these anchors at a moderate cost. Pipe line engineers are an inventive crew. No doubt, as the necessity arises, practical and economical methods will be devised to install these anchors wherever they are applicable. It is conceivable that this may be done without the services of a diver.

It was mentioned above that concrete and cast iron anchors would not be damaged by corrosion. The possibilities of corrosion on this newer anchor are summarized here. As has been noted, all of the components of the assembly are of steel or malleable iron. The question naturally arises as to whether these parts will resist corrosion any better than the pipe itself. In the past it has been common practice to furnish the assemblies with galvanized saddles and anchor rods. The anchors themselves are of heavy malleable iron and it has not been thought necessary to attempt corrosion mitigation on these.

Considerable study has been made of the effects of corrosion on galvanized anchor rods. Most of this study has been made with companies which have been using this type of anchor for many years, such as power companies and the telephone systems. It has been found that these anchor rods under certain conditions will corrode. In a few instances, the rods became useless in less than ten years. In other cases, rods were pulled up that showed a conservative life estimate of 20 to 30 years. The pipe line engineer no doubt would desire these anchors to be of as long life as the line itself, and this is easily possible.

When long life of the anchors is necessary, the rods may be protected by coating them with synthetic rubber. The saddles may be coated with the same material used to protect the pipe line. Due to the thickness of the metal, it is not thought that the anchors will be materially damaged by corrosion. Then, when the assembly is in place on the pipe line, a small electrical connection can be made to the pipe wall. The same cathodic protection would then be obtained on the assembly as is maintained on the pipe line. This is but one method possible to combat corrosion possibility. Others may be used. It is easily possible to design the line so that the anchors will have as long a life as the pipe itself.

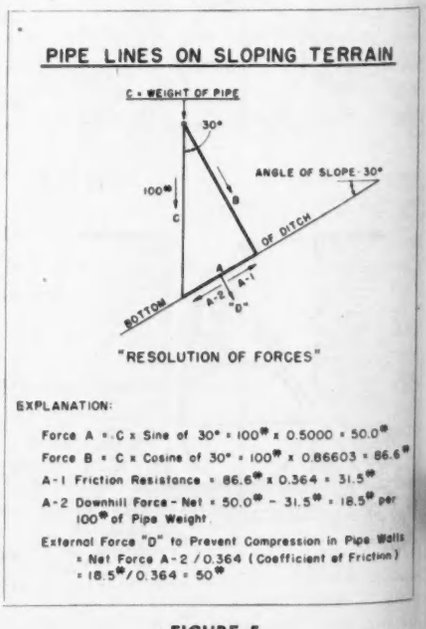
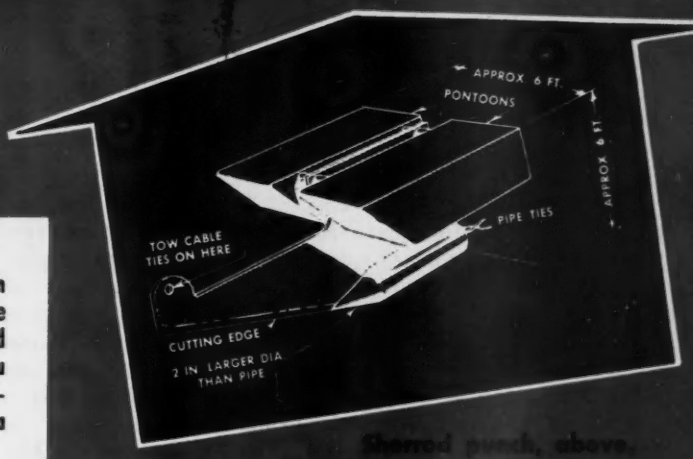

PIPE LINES ON SLOPING TERRAIN
C = WEIGHT OF PIPE
30°
ANGLE OF SLOPE 30°
100#
C
B
OF DITCH
A
A-1
A-2
D
BOTTOM
"RESOLUTION OF FORCES"
EXPLANATION:
Force A = C x Sine of 30° = 100# x 0.5000 = 50.0#
Force B = C x Cosine of 30° = 100# x 0.86603 = 86.6#
A-1 Friction Resistance = 86.6# x 0.364 = 31.5#
A-2 Downhill Force - Net = 50.0# - 31.5# = 18.5# per 100# of Pipe Weight.
External Force "D" to Prevent Compression in Pipe Walls = Net Force A-2 / 0.364 (Coefficient of Friction) = 18.5#/0.364 = 50#

FIGURE 5

THIS NEW SHERROD PIPELAYING METHOD...

LICKS LOUISIANA MARSH, RIVER CROSSING JOB FOR THE TEXAS CO.



Sherrod punch, above, makes size-larger hole than pipe being towed — permits water blanket around pipe, reducing co-efficient of friction. Leaves pipe wrapping undisturbed.

The Texas Co. had 44,500′ of three, four and six-inch Schedule 160 pipe to be laid for high pressure lines in the Bateman Lake Field . . . really a tough job, since pipe had to be laid through Southern Louisiana's marshy bayou country. Added to that, project included five canal crossings and a 1428′ crossing of the 100′ deep Atchafalaya River.

ATCHAFALAYA CROSSED IN 33 MINUTES

Contractor on the job, Buddy Sherrod, Inc., used new Sherrod Punch-Pull pipelaying method, to hang up such production records as 1670′ of three-inch pipe laid through marsh land in one day; 5,250′ laid in five days; and the Atchafalaya River crossing—1428′ wide and 100′ deep—completed just 33 minutes after the pipe section had been fabricated and tested!

ELIMINATES USUAL HIGH-COST FACTORS

Besides production records that slash manhour and operational costs, Sherrod's new method of laying pipe by pulling it underground eliminates high cost of pipe stringing, ditching, diking, and back-filling. Cuts out excessive equipment charges too, since only three major pieces are required. Eliminating all these high cost factors means a big reduction in job costs—a saving passed on to you as client.

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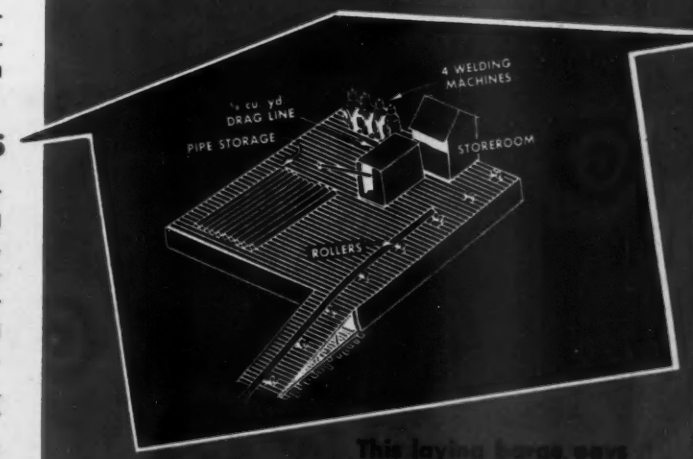
Remember, these are specialized services, immediately available to solve *your* job problems. Sherrod handles toughest *marine, marsh* or *river* jobs in a hurry and at a fraction of usual costs. It will pay you to write today for complete information.



This laying barge pays out fabricated pipe as it's pulled underground by cable from spud barge. Special rubber rollers protect pipe wrapping and speed production.

BUDDY SHERROD, INC.

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CONROE, TEXAS

CARE and MAINTENANCE

Oil and Gas Fuel Mixture Reduces Operating Costs

By GILBERT M. WILSON
Pacific Coast District Editor

IMPROVED operation, lowered fuel costs and reduced maintenance are some of the outstanding benefits that followed the conversion of two pipe line pump station engines from fuel oil to a combination oil and natural gas fuel mixture.

At the Hobbs, N. M., crude oil pumping station of a pipe line company operating in that area two single-cylinder, 150-horsepower, four-cycle oil engines are used to drive two 5 x 24-inch duplex pumps connected into an eight-inch crude oil pipe line. In an attempt to attain a higher horsepower output of the engines, so as to permit developing higher pipe line pressures, and at the same time reduce maintenance costs such as those involving cleaning of valves, rings and fuel nozzles, experiments were conducted in which a measured amount of dry fuel gas was injected and mixed with the oil then being used as fuel. After a number of experimental runs were made, it was determined that when the fuel mixture that was taken into the cylinder was of a ratio of about three-fourths fuel oil and one-fourth natural gas, greatly improved engine power output and performance resulted.

Where formerly it had been necessary to clean fuel injection nozzles and valves at very frequent intervals, it now was possible to operate the engines for several months at a time without necessity of cleaning critical points in the fuel intake and engine manifold system. Fewer stuck piston ring jobs occurred, and accumulation of carbon was reduced considerably. When an engine was torn down for routine inspection, rings generally were found to be clean, and whatever carbon had formed was relatively soft and easily removed. Maximum pump

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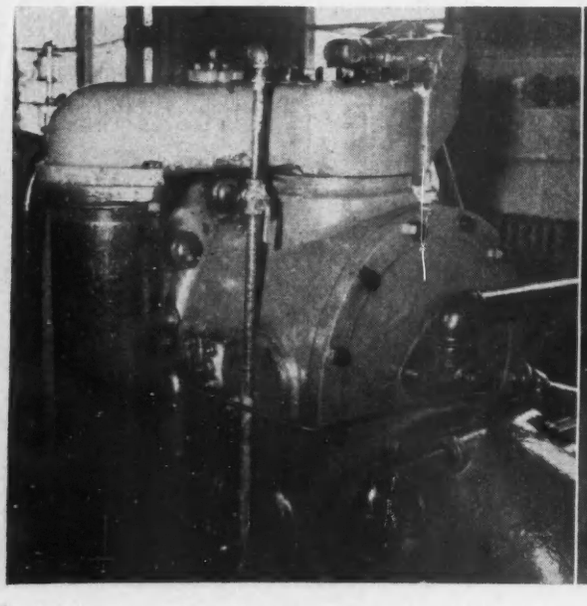
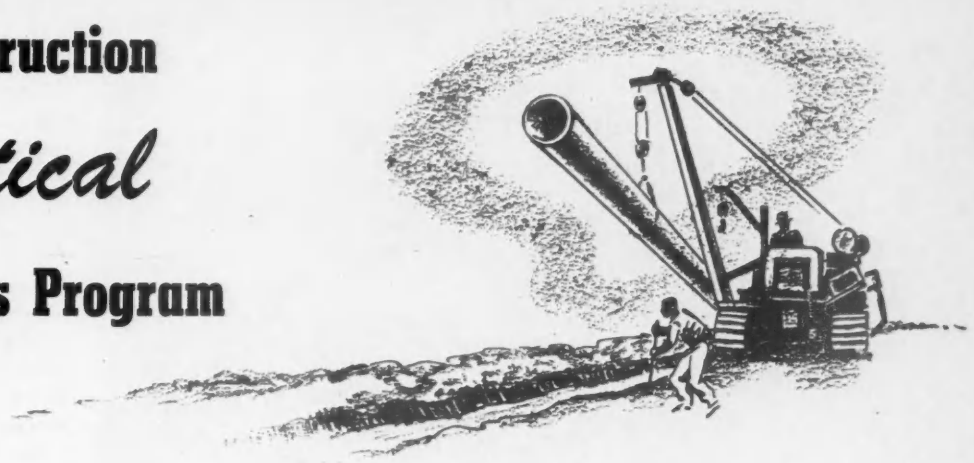


FIGURE 1. Natural gas is delivered through a ½-inch line to a port in the top of the intake manifold. Here it is combined with the fuel oil in a mixture of approximately three-fourths fuel oil and one-fourth natural gas.

FIGURE 2. Close-up view of water governor installed on the ½-inch gas supply line. Connected to the engine jacket water circulating pump, governor shuts off gas supply if engine should slow down or stop. Also visible is the 15-pound gas pressure regulator located to right of governor.

Pipe Line Construction As a *Practical* Public Relations Program



By GENE MILLER

Interstate Oil Pipe Line Company, Tulsa

FORTUNATELY for all concerned, there is a growing realization that the public relations program of today goes far beyond the activities of a few highly trained press agents, publicity specialists and advertising men. It is true that in many companies the general program is administered by specially trained personnel, and that considerable effort is devoted to placing the company's message before the public through effective publicity and carefully planned advertising.

But practical public relations, the kind which the oil industry is striving to develop to a high degree of perfection, is a matter in which all employes participate, consciously or otherwise. Even such a commonplace action as an employe buying a loaf of bread, in the final analysis, can be called a public relations project because the general public (the grocer in this case) often judges a company by the employes with whom it comes in contact.

Good Citizenship

Practical public relations, lifted from the too-generally accepted notions of Hollywood press agent tactics, is actually a matter of good citizenship on the part of management and employes, and a genuine desire to show neighborliness and consideration in day-to-day associations with the general public.

Interstate Oil Pipe Line Company, in beginning construction of a new crude line from Elk Basin field to Billings, Mont., encountered a problem situation in which practical public relations were, to a considerable extent, the most effective solution.

Basically, the situation was one in which the pipe line was regarded as an intruder in an area which is noted for its productive and profitable farm lands.

In the Clarks Fork and Yellowstone River basins, irrigation and dry farming methods have transformed semi-arid plains country into fertile farm lands from which are harvested large quantities of sugar beets, beans, cereal grains and hay. Much of the area is not proven oil land, and the landowners along most of the right-of-way had had no previous contact with the oil industry except at the filling station.

For these and other reasons, the coming of the pipe line was a matter of deep concern to some of the farmers who visualized the extensive damage which might be caused by interruptions in irrigation schedules, by ditching and heavy hauling operations across their carefully tilled and leveled fields, and by the intrusion of inspectors and maintenance crews in the years to come.

As a common carrier pipe line company, Interstate has the right of eminent domain. Had friendly relations with the local people not been desired, it could have condemned the necessary right-of-way, built the line, and let the courts decide what damages should be paid.

Fortunately, the company realized that it would probably be operating in the area for many years to come, and that a friendly working relationship with the local inhabitants was very desirable.

Company officials, working closely with the personnel of the Northwest District office in Billings, put themselves mentally into the farmers' shoes, and looked at the problem from the local viewpoint. They soon saw that there was much to be said on the farmer's side of the story.

There are more than 1½ million acres of rich farm lands in the Billings trade territory, of which about 650,000 are under irrigation. Agriculture in this area is the basic industry, and one which provides very substantial incomes for those engaged in it. But, with the exception of grain crops grown by the summer fallow method, farming is almost wholly dependent upon irrigation.

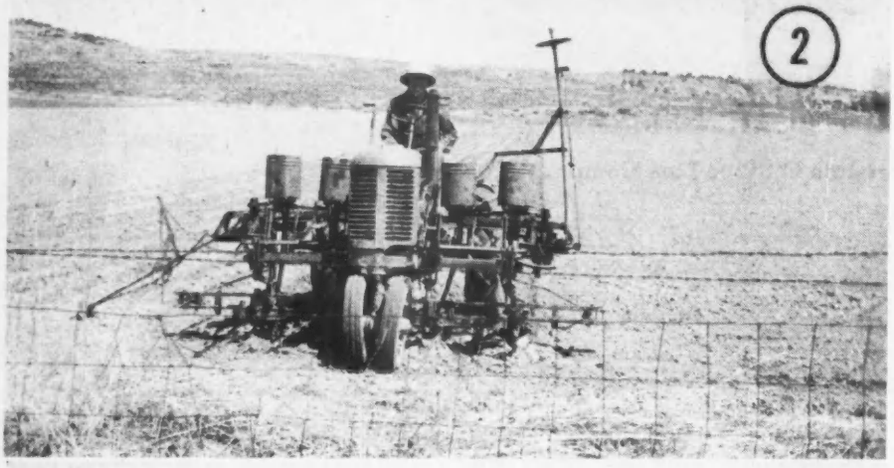
Farms in the area are tilled to tabletop smoothness, and the texture of the soil is tediously worked into a uniform consistency which will make the irrigation water spread evenly across the fields.

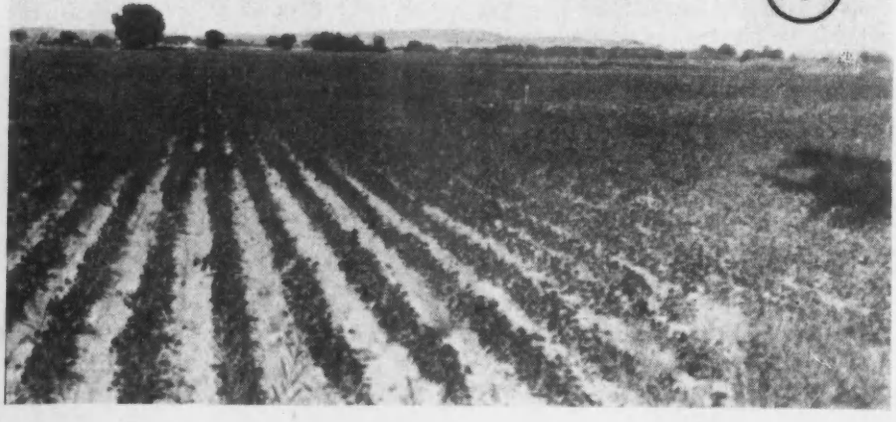
Anything which disturbs the condition of the soil or the contour of the land can change the flow of the water, and major changes can result from seemingly minor disturbances.

Planned Procedure

In such a situation, it was natural for the farmers to consider the coming activities and machinery which are necessary to modern pipe line construction as a catastrophe. Understanding this, the company officials resolved to construct the line in such a way as to cause a minimum of damage and inconvenience to the farmers along the route.

A construction schedule was adopted which would cause the least possible disturbance to irrigation and harvesting activities along the line. The contractor





on the job, a local firm with a former Interstate employe as construction foreman, agreed to the schedule and to the added precautions he was asked to take.

The new line was laid in three sections. The first, from Billings to Laurel, was laid in advance of the planting season and its related seeding and irrigation activities. The second was through the semi-arid regions northward from Elk Basin field, which were south of the area of intensive farming. Construction of the final connecting link, which passed through some of the finest irrigated land in the region, was delayed as long as the race between harvest season and oncoming winter would permit.

But in a race with Montana winter, this general schedule was not enough. Right-of-way agents of the company, acquiring easements for the pipe line, worked closely with the farmers in developing a practical and mutually satisfactory agreement as to the time at which the construction crews would cross each parcel of farm land. Naturally, it would be impossible to follow only the individual farmer's desire in each instance, but in virtually every case an agreement was reached which would permit the construction of the pipe line to progress smoothly without unnecessary inconvenience or monetary loss to the farmer. In many cases, a deviation of only a few days from the schedule agreed upon would have had serious consequences.

At first, when pipe deliveries were rather slow, it was easy to follow the schedule established. Later, as pipe deliveries were speeded up, and as the two new refineries at Billings neared completion, there was some desire to push the line to an earlier completion; but agreements were observed.

Full credit must also be given to the contractor for carrying out his part of

1. Looking north into the Clarks Fork River Basin where careless construction crews could cause considerable damage to irrigated farms.
2. Unidentified farmer, whose land is crossed by the pipe line, watches construction crews at work.
3. Large pieces of construction equipment such as the stringing truck shown here were not permitted to turn around on the right-of-way, since to do so would have required backing or pulling into cultivated land beyond the 40-foot boundary line.
4. On irrigated farms a few days' delay of a scheduled watering might mean loss of the crop. Construction of the third section of the line through the irrigation belt was carefully timed through agreements with the farmers to follow the harvest northward through the area.

PHOTOGRAPHIC MAPS
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the practical public relations program to the letter.

Among the special precautions and practices which were observed in the farm country was the strict observance of the right-of-way boundaries by construction and company personnel. Drivers and operators of bulldozers, company cars and other pieces of equipment drove within the 40-foot right-of-way strip wherever humanly possible. Turnarounds requiring more space were performed by driving "around the block"—leaving the right-of-way by some approved access lane or road and returning to it at some other point.

Traffic to and from the right-of-way was always careful to use the routes designated by the landowners, and vehicles were parked in areas which the farmer approved.

Drivers of service trucks bringing fuel and other supplies to the job were carefully briefed on the routes to be used, and on the precautions to be observed while on the right-of-way.

Everyone on the job, from the spread foreman to the waterboy, made a constant and conscious effort to avoid any unnecessary damage to fences, trees, water distribution ditches and similar fixtures along the right-of-way.

Finally, as the line was completed, every feasible effort was made to restore the land to as near its original condition as possible. Among the major special measures employed were separation of top soil and sub-soil so that they could be replaced in the proper order, and packing and smoothing off the backfill to restore the levelness of the land. Backfills have been, and will be, subject to subsequent inspections and refilling where noticeable settling has occurred.

Actually, it was not too difficult for the contractor's men and Interstate's Northwest District personnel to follow these special instructions. Being for the most part natives or long time residents of the area, they understood and appreciated the farmer's problems and attitude.

But the fact remains that these people, by being considerate of the other fellow, and by performing simple acts of thoughtfulness and cooperation, established a far more friendly working relationship between the farmers and Interstate than would have resulted had the company rammed through the line with the utmost speed, disregarding the feelings and the problems of the local people.

This is only part of the story, of course. In addition to the special precautions observed, Interstate followed those practices of design and construction which any major pipe line company would consider natural and essential in the same situation. First grade pipe was used throughout the job, and every step of construction was doubly inspected. Modern, effective coatings of hot enamel, glass fiber and asphalt-impregnated paper were used for maximum protection against corrosion. Major river, stream and irrigation ditch crossings were constructed of heavy duty pipe and were given extra protection against damage and corrosion where necessary.

These, and similar measures are standard pipe line practice, because all major companies are fully aware of the ill will and financial consequences which can result from a leak in a stream crossing or under an irrigated field.

But in an area which has had little or no former experience with the oil industry, these comforting standard practices are not known or understood. And without a sincere and effective program of practical public relations to win some measure of public confidence and acceptance, the opportunity to explain these and other favorable characteristics of the oil industry in a convincing manner will be seriously limited.

Practical public relations become doubly important in the case of a pipe line company because in many instances a pipe line company is a particular area's first and often its only contact with the oil industry.

And just as the public uses its contacts with an individual employe in judging a company, so it uses contacts with an individual company to judge an industry.

Oil and Gas Fuel Mixture Reduces Operating Costs

• CONTINUED FROM PAGE 220

discharge pressures, which formerly seldom exceeded 700 pounds per square inch, now could be brought up to 850 and 900 pounds pressure, and without appreciable slowing down or "lugging" of the engines. The pumps handle on an average of 20,000 to 22,000 barrels of crude per day.

Water Governor on Gas Line

The work entailed in converting the engines was comparatively simple, and required no special tools or equipment other than a regulating device that would automatically cut off the gas supply in the event the engine should fail while no one was in attendance at the station. Gas was brought in through a one-half inch line, visible in Figure 1, and entered the top of the intake manifold near the intake valve. A cock was installed in the line at a convenient point near the manifold. Dry gas taken off the main supply line is admitted to the engines at 15 pounds per square inch pressure.

Guarding against the possibility of gas escaping should the gas intake line break or the engine fail, is a water governor operating off the discharge side of the engine jacket cooling water pump, the latter belt-driven off the engine flywheel shaft. The governor, carried in the one-half-inch gas line, is set to operate normally at about 22 pounds water pressure. If for any reason the engine should slow down or stop, the water pump speed would be affected accordingly, and would cause a drop in pump discharge pressure. Should the water pressure fall below ten to 12 pounds per square inch, the flow of gas would be cut off. The water governor installation is shown in Figure 2. Also visible is the 15-pound gas pressure regulator located several inches down stream from the water governor. This easily accessible group, of which there is one for each of the two engines, is set up only a few feet from the engine.

Fuel Oil Savings

Appreciable savings in fuel oil consumption have resulted from this conversion. Formerly, fuel oil was consumed at a rate of approximately 300 barrels per month. Consumption is now reduced to only about 190 barrels monthly. Cost of the dry gas is a factor to be considered also, but it by no means approaches the cost of the fuel oil saved, and even if costs were equal, the improved performance of the engines, increased output of the pipe line pumps, and savings realized in reduced maintenance, would have made the conversion well worth while. Where formerly the engineer on duty had to spend much of his time cleaning, overhauling and repairing the engines, he now is able to devote such time to general inspection and routine maintenance work. With the exception of periodic overhauls when at least two men are required to handle the heavy engine parts, most of the station maintenance now is handled easily by the man on shift.

Cost of the conversion was slight, since only the regulator, water governor and one-half-inch pipe fittings were required for the job. The time that was spent to experimentally determine the proper mixture also is a small cost when compared to the fuel savings, increased output of the station and extended operating life of the engine.

Announcing

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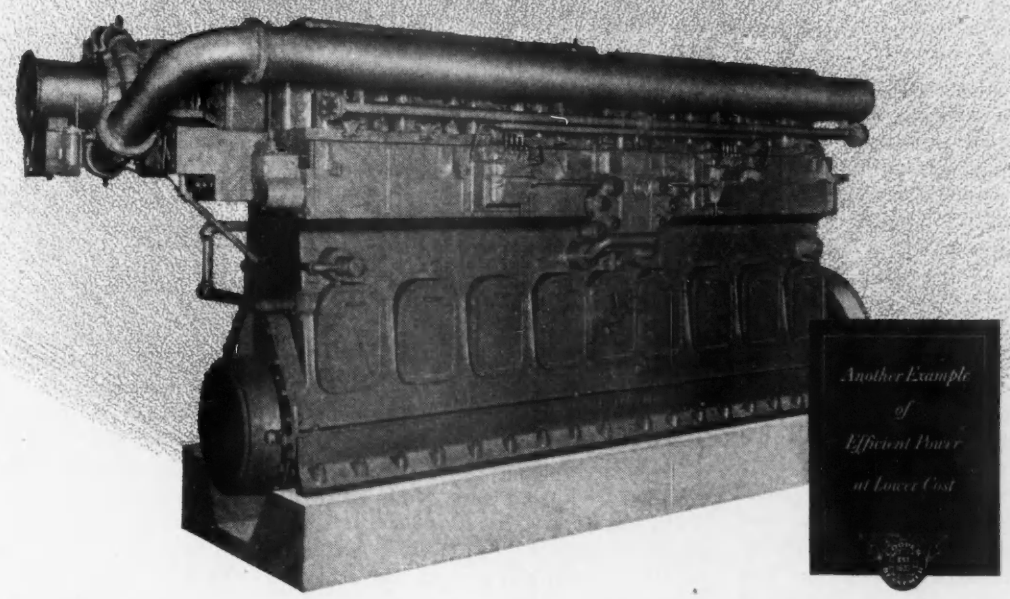

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Like ordinary gas engines, Cooper-Bessemer *supercharged* 4-cycle gas engines are spark-ignited, requiring no pilot oil charge. However, they offer at least 50% higher thermal efficiency, consuming less than 7,000 BTU per horsepower hour — easily a 30% saving in fuel.

Moreover, by successfully increasing brake-mean-effective pressure from the usual 70 pounds to 125 psi, the new supercharged engines produce 80% more horsepower. Thus any power need can be met with fewer or smaller engines, permitting additional big savings in installation, housing, piping, maintenance and normal operating overhead.

For further data, for specific information on what this new development offers in meeting your particular needs, check with the nearest Cooper-Bessemer office.

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Submerged-Arc Welding Speeds Double-Jointing 30-Inch Pipe in the Field

General view of double-jointing operations at the Melville, La., yard.

By J. E. KASTROP
Gulf Coast District Editor

DOUBLE-JOINTING 30-inch line pipe in the field by the automatic submerged-arc welding process is proving to be not only a time saver in construction, but is also reducing welding costs and is effecting advantages in the weld itself. Contracts to double-joint a total of 291 miles covering the first three schedules of the Transcontinental Gas Pipe Line have been let by Fish Constructors, Inc., to the Shamrock Construction Company, which is nearing completion of this first trial job.

Joining two 31-foot sections of pipe in the field by machine will eliminate almost half the number of hand or firing-line welds that will be required on the first leg of construction of the world's longest gas pipe line. In addition to savings in welding costs and added speed in laying the line, an equally important advantage gained in this process lies in producing a high-quality, uniform bond between the two metals. After the variables have been determined to produce a weld of maximum strength, an unlimited number of similar welds can be made under these same conditions. In hand welding, the human element cannot be neglected, regardless of how perfect the welder may be. In this type of machine welding, only the physical variables need be controlled to insure that the welder is functioning properly to produce the same quality weld from beginning to the end of the double-jointing operation.

SUBMERGED-ARC WELDING, originally designed for use in pipe fabrication plants, was recently applied with success to double-joint 30-inch diameter pipe in the field. Substantial reductions in time, welding costs and storage difficulties have been effected by this method on the first 291 miles under contract for the Transcontinental Gas Pipe Line.

On such an enormous construction project as the Transcontinental Gas Pipe Line, inspectors obviously cannot oversee the welding of each joint. Much of the inspectors' burden in this respect has been relieved by machine welding the large diameter pipe in the field. It is anticipated that the uniform and controlled bond made between the two joints will minimize any future trouble which could originate from the weld.

Process Not New

Submerged arc-welding is an electric process using the heat generated by the passage of an electric current from an electrode to the metal being welded so that the welding action takes place under a blanket of flux material. This process is not new in pipe fabrication plants. Thirty- and 31-inch diameter pipe for the Trans-Arabian Pipe Line was made from flat plate steel that had been rolled and welded longitudinally by this method. Smaller diameter pipe has been double-jointed in the factory by the submerged arc-welding process. In fact, the 30-inch diameter pipe fabricated at Consolidated Western Steel Corporation's plant at Maywood, Calif., employs this method in making longitudinal seam welds on the 31-foot long joints supplied to Fish for Transcontinental Gas Pipe Line. The outstanding feature about double-jointing the 30-inch pipe at strategically-located pipe yards along the line is that this is the first time the principle has been employed successfully in the field by equipment that could be transported easily from yard to yard.

During the earlier period of double-jointing with this method in field pipe yards, the welds completed in a day's operation were relatively few. However, after some experience was gained by operating personnel, and ample pipe was readily available, as many as 124 complete welds per day were made. The average number of welds made during a good day's operation runs between 85 and 90. Approximately 85 double-jointing welds are made per mile of this 30-inch pipe. Exclusive of the number of helpers required by the double-jointing operation, those figuring directly in the welding process are two tack welders, two welders on stringer beads, and one machine operator. A normal double-jointing crew doing this same job in the field by hand welding will require about 25 helpers and five welders. This latter crew will complete about 60 welds per day. Simple arithmetic shows that twice this number of welds can be made in one day's operation with the automatic double-jointing machine.

Under this original contract to double joint 291 miles of 30-inch pipe, an esti-

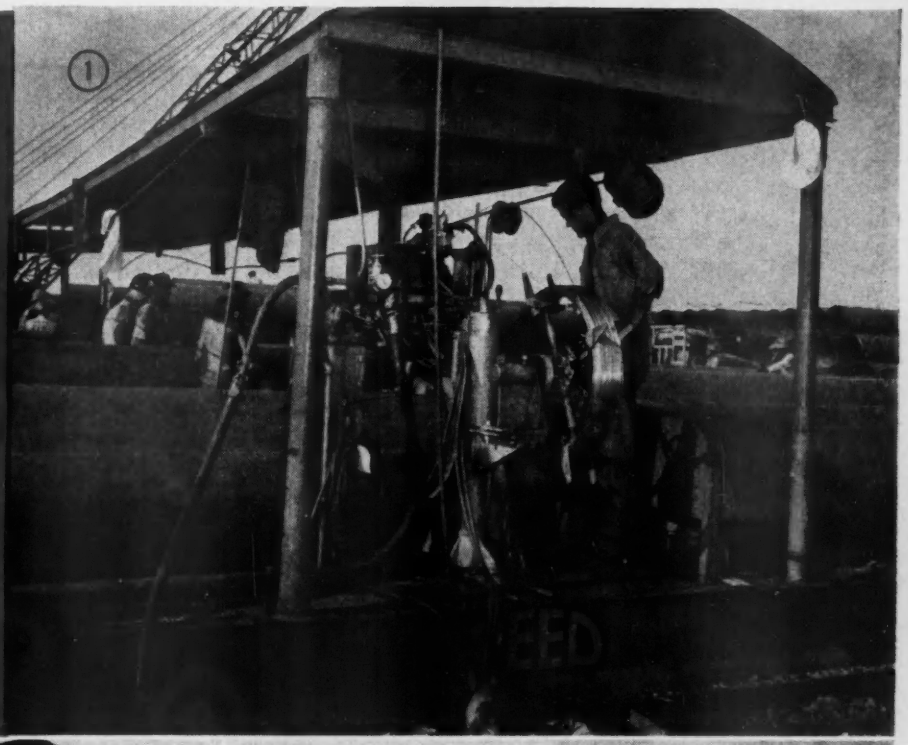
1. Back view of the submerged-arc welding equipment showing operator carefully observing the welding action and checking the flow of flux.

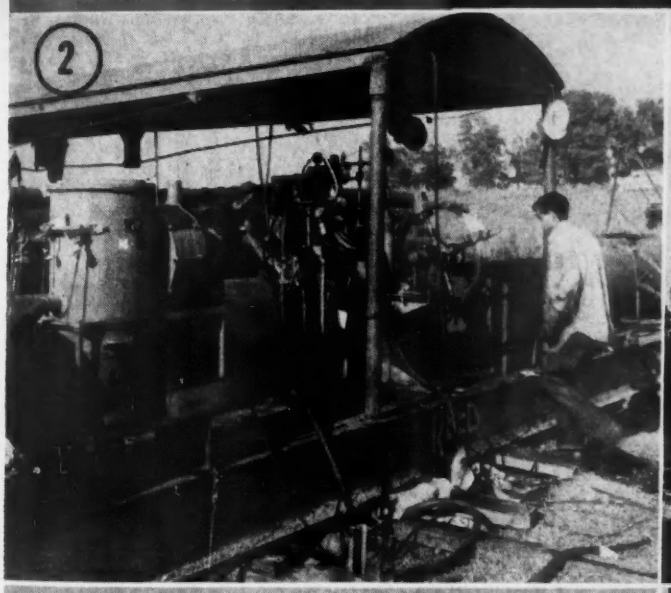
2. Flux is recovered by vacuum generating equipment shown at left.

3. All welding work is completely covered to preclude interruption due to rain.

4. Single 31-foot joints are unloaded from trucks and placed on the pipe racks which lead to the automatic welding machine.

5. Welder in the foreground is running the stringer bead preparatory to placing the pipe in the automatic welding machine.





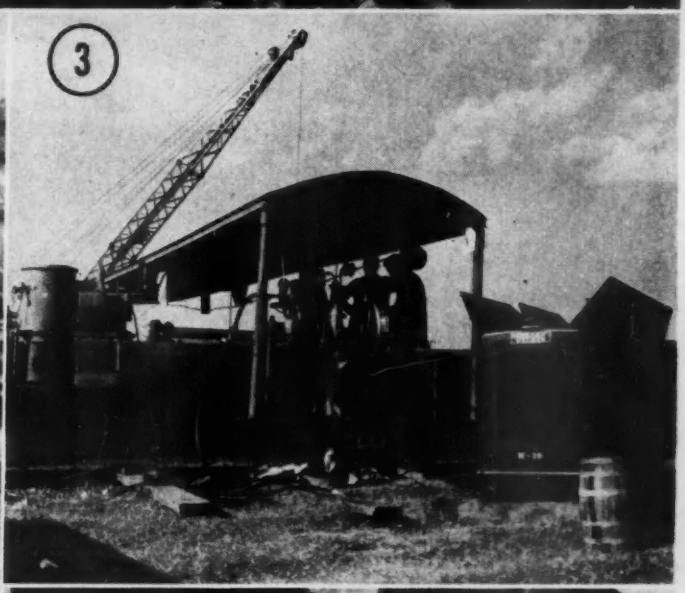


Fig. 2—Cutaway sections of this 100,000,000 SCFD unit shows the Aerotec tubes, heart of the dry scrubbing method used on all Aerotec Gas Scrubbers. This horizontal construction is particularly adapted to cleaning gas of liquid and distillates.

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Fig. 1—Bristoria Station on the "BIG INCH," installed for Texas Eastern Transmission, shows four 100,000,000 standard cubic feet per day scrubbers manifolded to provide a capacity of 400,000,000 SCFD.

Fig. 3—These units handle dry dust more advantageously, because of their vertical design, but may also be used for the removal of liquids or distillates. Both types can be built up to 100,000,000 SCFD capacities.

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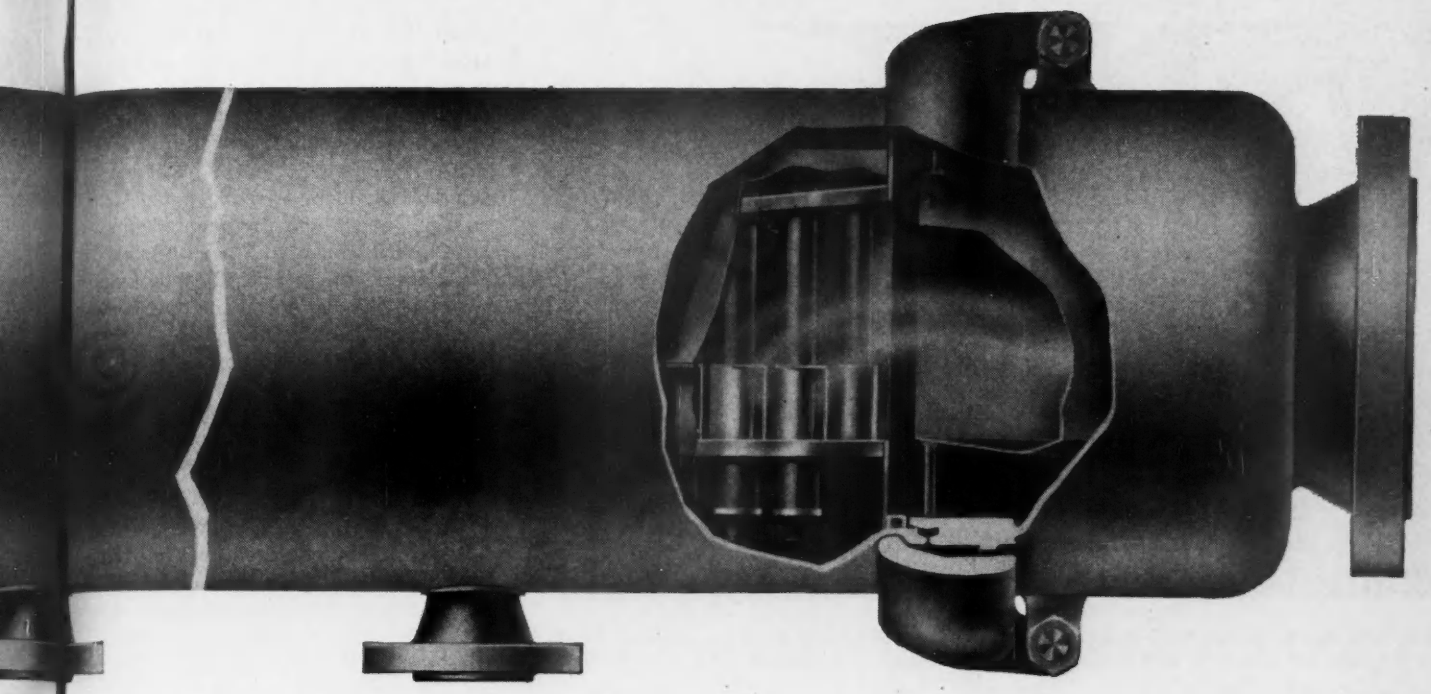

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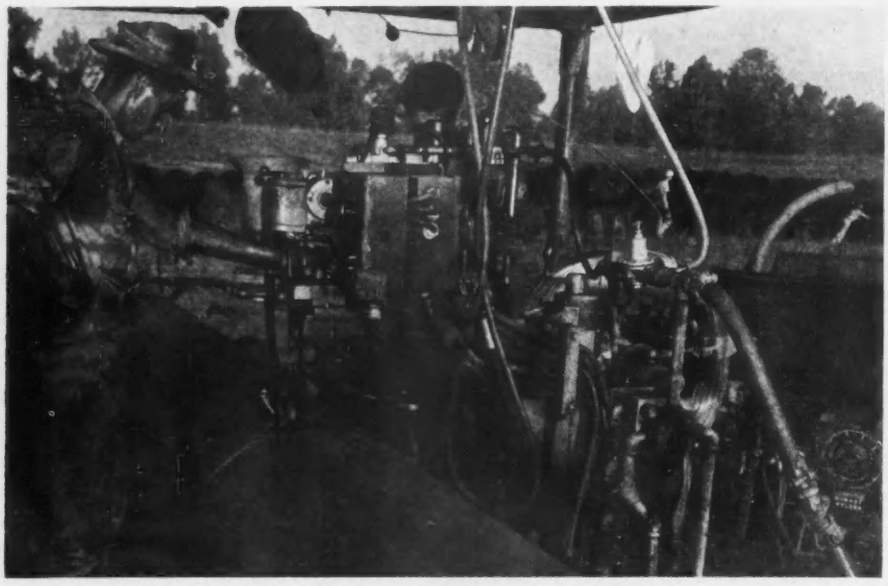


Right side view of welding head showing the electrical control boxes whereby the operator adjusts both current and voltage for each pass. Compressed air is supplied through the rubber hose at right.

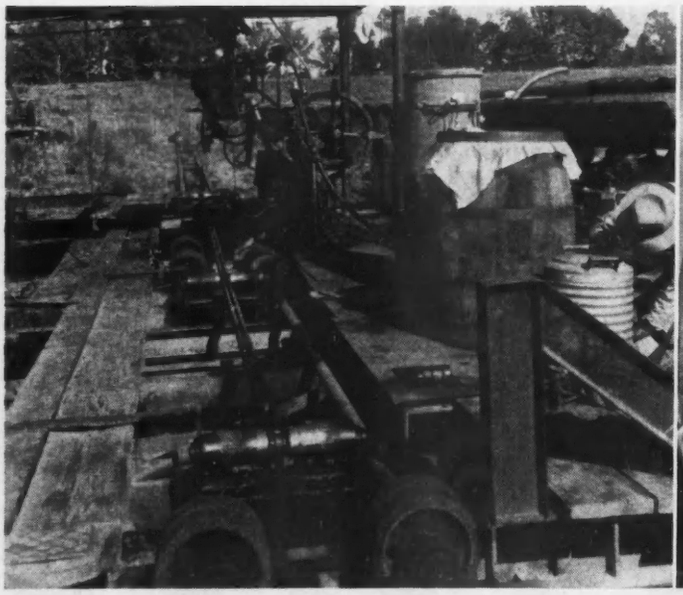
mated 25,500 welds will be required. Of course, an equal number of welds must be made by hand along the line, plus an additional number of hand welds to absorb the "pup" joints in the line.

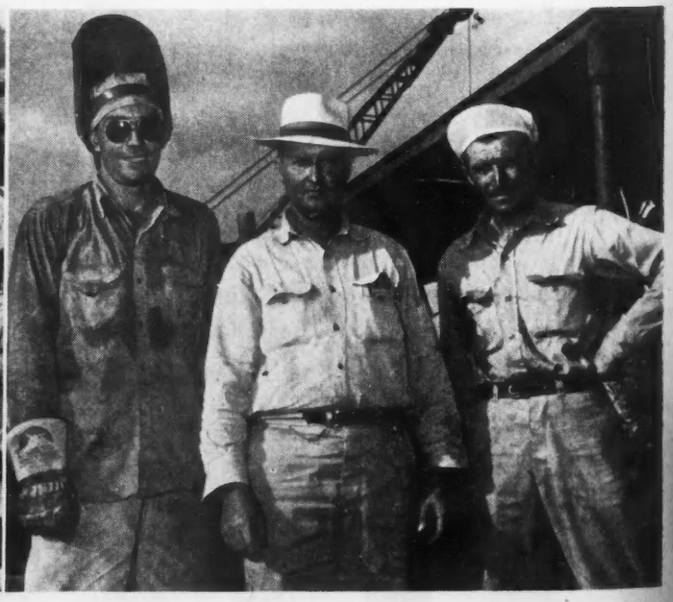
Due to the portability of the double-jointing equipment, it was found extremely desirable from a transportation-saving standpoint to establish several small pipe storage yards near the right-of-way, rather than use large central pipe storage yards. Not only does this practice reduce the hauling costs of the heavy pipe, but the problem of unloading freight cars is simplified. It is a big job to unload 100 cars of 30-inch pipe at one time, whereas five or six unloading yards near the pipe line right-of-way can handle this number easily when distributed over the smaller yards. Therefore, present practice is to lease small areas near railroad sidings and also as near the main pipe line as possible to unload and store the single joints. At the smaller pipe yards, the double-jointing equipment is set up in two or three hours and the pipe welded. After it has been double-jointed, it is stored awaiting the stringer contractor's trucks for hauling to the pipe line right-of-way.

Pipe received in the smaller yards is stacked in long double rows not more than four joints high. Welding equipment is set up at the end of a double row and the pipe is lifted by crane to the pipe racks, which are wide enough to accommodate two joints abutting each other. Several joints are loading on the pipe racks ready to be aligned and tack welded.

Helpers roll the two joints of pipe to the first position where alignment clamps are run in one end of the paired joints. These clamps are electrically powered and controlled by a switch mounted on the end of a piece of one-inch pipe, the opposite end of which is attached to the clamp. This small pipe serves as a conduit for the electrical conductors inside, as well as to prevent tangling the wire in the clamp as it crawls out of the pipe after the tack weld is made. The alignment clamp operator follows the control switch as the clamp travels to the point of juncture of the two sections of pipe. When the alignment is complete, the tack weld is made and the clamp reversed so it will back-track out of the joint. The operator withdraws the clamp out of the pipe and into a housing made from 30-inch pipe. This housing is fitted with alignment lugs around its circumference so it can be easily lined up prior to running the clamp into the line pipe. The joint is quickly tack-welded, after which helpers roll the two joined sections along the pipe racks for about six feet to the first welder who runs a stringer bead around the joint using three-sixteenth-inch rod.

When the stringer bead is finished, it is carefully cleaned with an electrically-powered wire brush. Any protrusions along the weld are chipped off by an air chisel so that a clean joint results. The





Left. **Welding head is in operating position but the machine was left empty to show the pipe handling equipment. Rubber-tired wheels are powered by an electric motor geared to the shaft. Longitudinal steel rollers which convey the pipe out of the machine and down to storage are pneumatically controlled.**

Right. **Behind the guns on Rig No. 1 are, from left to right, Glen Owens, welding inspector, Fish Constructors, Inc.; J. C. (Preacher) Brown, general superintendent, and R. F. Duncan, foreman, Rig No. 1, both with Shamrock Construction Company.**

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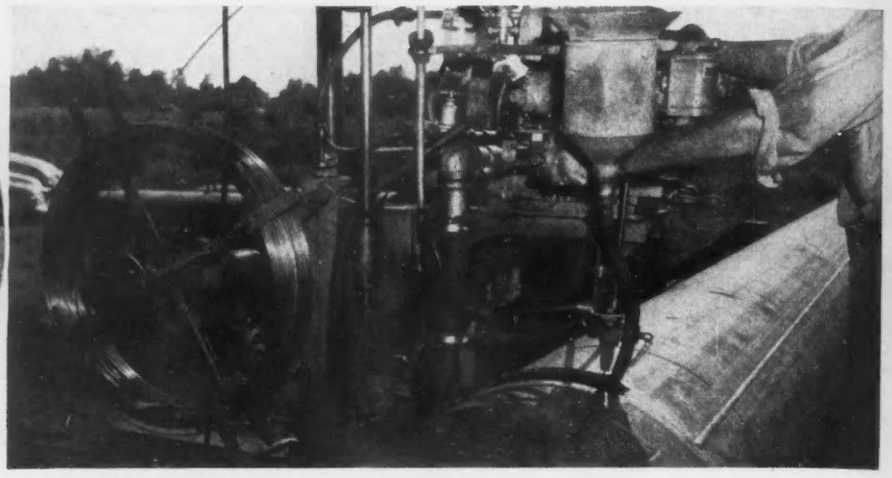

Left. **Closeup of welding action of machine. Flux is fed to the weld by a rubber hose, the nozzle of which is located at the left and can be seen depositing the granulated flux. Note the pointer attached to the flux hose nozzle so the operator can accurately guide the head over the center of the seam.**

Right. **Operator controlling the welding head as the filler bead is run. Granulated flux is placed in the cylindrical hopper near the operator's left hand.**

pipe is beveled at the factory to facilitate field fabrication.

The inspector who cleans the joint after the filler bead has been run places a stamp near the welded joint in order to clearly identify that particular weld as one that has been made by the double-jointing contractor. In the event trouble arises from a weld on the main line, it will be easy to identify the weld.

Helpers then roll the pipe onto longitudinal rollers on the welding machine. These rollers are pneumatically elevated and lowered, and receive the tack-welded joints at the raised position. The machine operator then lowers the paired joints onto the rubber-tired rotating wheels which turn the pipe at a predetermined speed by an independently-controlled electric motor.

A ground is clamped to one end of the pipe, the welding head positioned over the V-joint, and the filler bead is made. The welding head is equipped with a pointer which serves as a guide to the operator who controls the welding operation. One of his primary functions is to position the welding head so the rod is fed into the center of the grooved joint. A mark is made where the weld starts so the operator will know when the filler bead has been completed. Flux covers the seam so the operator cannot look directly at the welding action to determine when the joint is completed. Actually, some overlapping occurs to insure a complete weld. This first pass by the automatic welder is made at 520 amps with 32 to 34 volts across the arc.

A special granulated material or welding composition is automatically spread over the welding action to seclude the arc and molten puddle from view. This flux material is fed into a hopper mounted to the head above the point of contact with the pipe. It flows by gravity and the rate of feed is controlled by a hand valve in the feed line. The weld action takes place beneath this sheath of flux, which serves several purposes. It eliminates sparks, splatter and flash, as well as providing a liquid blanket of molten flux over the surface of molten metal. The flux makes possible the use of high current densities which permits the rapid generation of intense heat. It is a good heat insulator and thus concentrates the heat in a relatively small welding zone. This flux also controls the shape and appearance of the completed weld. It acts as a cleanser in absorbing impurities from the fused metal and also performs the important function of excluding the atmosphere from the molten metal to prevent any degree of oxidation.

Vacuum Head

A vacuum head located over the center of the welded seam but lower around the circumference of the pipe sucks up and recovers the excess flux, which does not solidify during the welding process. This excess flux is drawn through a large flexible hose and is stored in a cylinder on the vacuum generator.

An endless welding rod 5/32 inch in diameter is coiled on a free moving reel mounted on the vertical column which supports the welding head. The rod is fed into the weld by an air-powered motor which is considered simple and rugged to withstand the heavy-duty work required in this process. The rate of rod feed depends upon the amount of current being used in making the weld. Obviously, the greater the current, the faster the welding rod will be melted and deposited on the seam. The automatic air voltage control valve governs the amount of air entering the air motor on the welding head. It causes the motor to run at the proper speed to maintain a predetermined voltage across the welding action. The welding action taking place is entirely automatic in every respect, and the machine need only be set to predetermine conditions to make a uniform, high-strength weld.

When the first pass is complete, the operator makes minor adjustments for voltage and current and the second pass is started. The finished bead is run at nearly 590 amps and between 36 and 38 volts. The rate of welding around the circumference is approximately 38 inches per minute, requiring little more than 2½ minutes to make the complete pass around the 30-inch diameter pipe.

As the finished weld is completed, the machine operator stops the welding action and the pipe is pneumatically raised to the transfer point where helpers push the 62-foot joint out of the machine onto a roller conveyor. The double-jointed section is allowed to cool and is carefully inspected. If any pits exist in the welded seam, it is filled in by hand welding. The pipe is then stacked or immediately loaded on the stringing contractors trucks for delivery to the right-of-way.

Development of equipment to utilize the submerged-arc welding method along the pipe line is a tribute to the vision of men in the field and their desire to do a better job, and to the manufacturing engineers and equipment fabricators, all of whom have cooperated in this project. The increased speed with which a weld can be made and the high quality of the bond will undoubtedly bring about the use of this process on other pipe lines, both oil and gas, now under construction or being planned.

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Choosing the *Right* Induction Motor

By E. H. FREDERICK
Application Engineer, Motor-Generator Section
Allis-Chalmers Manufacturing Company

THE AUTHOR describes the characteristics of motors suitable for oil field service, outlining the considerations which must be observed in selecting a drive for any of the various types of loading encountered in the field or pipe line service. He also lists NEMA standards which simplify the selection of desired driving units and outline their limitations.

THE use of induction motors, particularly those of the squirrel cage type, has become increasingly extensive. This growing popularity is based on good economic and engineering principles. In the case of small motors, that is, those under 200 horsepower, the induction motor is performing the greater part of the work.

The history of the induction motor dates back to the eighties when Ferraris and Tesla discovered the principle of the rotating magnetic field through the use of polyphase alternating currents. Obviously, these first induction machines had a great many serious drawbacks, and a certain amount of time was required to develop them into practical machines.

About the beginning of the twentieth century, the direct current motor was almost universally applied to electrically powered drives. However, the induction motor soon started to exert its influence because of its inherent advantages.

The main advantages in the use of the polyphase cage motor are, first of all, its simplicity of construction and operation, since the cage motor has no sliding electrical contacts and the only parts subject to wear and requiring maintenance are the bearings. The fact that the machine is very simple in construction, of course, allows its economical production, which in turn is reflected in the low first cost of these units. Simplicity of construction makes this type of motor particularly adaptable to the protective enclosures commonly required in the petroleum industry.

Furthermore, because these machines are so universally used, a great deal of work has been done to standardize mounting dimensions and frame sizes, which makes machines of different manufacturers interchangeable and allows the design of machines to provide maximum flexibility in the replacement of the motor.

A great deal has been done to improve the characteristics of these machines, and since these characteristics likewise have become standardized, a purchaser may be certain that if the motor is correctly applied, he should have very little trouble during the operating life of the machine.

Probably the best approach to the problem of the correct application of induction motors is to consider the functions which the motor must perform. A motor, after all, is nothing more or less than a torque-producing device. In its application to a driven machine the motor must do three things. It must be capable, first of all, of breaking itself and the driven machine loose from rest. It must then accelerate itself and the driven machine to operating speed, and, after it has reached operating speed, it must drive the load under the required conditions and with good operating characteristics.

Three General Types of Drives

The torque requirements during these three periods of operation are dependent to a large extent on the speed-torque characteristics of the driven machine. It is convenient to consider that all driven machines perform only one function, that is, to move material. The method in which the material is moved determines how the torque of the driven machine will vary with speed. In general, we may classify all driven machines into three broad categories. The first, in which direct action of the driven machine moves the material, results in constant torque operation, such as is represented by a reciprocating compressor or a positive displacement pump. In this type of drive, the positive action demands that a definite amount of torque be applied to keep the material moving regardless of the speed of operation.

The second general type of machine characteristics is that provided by centrifugal devices. In such machines motion is imparted to the material by means of a motivating element which "slips" with respect to the motion of the material. In other words, the motion of the material is more or less induced by the action of the impeller. The most common examples of such types of drive are centrifugal pumps or blowers, which have the speed-torque characteristics in which the torque demand varies as the square of the speed of operation.

The third general type is that which

About the Author

E. H. FREDERICK, a native of Milwaukee, received his E.E. degree from Marquette University in 1931. From then until 1936 he worked in various positions on the Allis-Chalmers Manufacturing Company electrical test floor where he had previously worked as an undergraduate during his cooperative training course. In 1936 he joined the Motor-Generator Sales section. In recent years he has worked primarily on special motor applications.

is known as a constant horsepower drive. In this type of drive, the amount of material being moved is so regulated that as the speed of operation increases, the feed is reduced so that the torque demand by the machine is reduced as the speed goes up. This type of drive is not frequently found in the petroleum industry. Machine tools are typical examples.

Since it is a requirement of the driving motor to start the load, to accelerate it, and to keep it running at operating speed, these speed-torque characteristics of the driven machines are an important item of consideration in the proper application of the motor.

If the method by which the induction motor produces torque is clearly understood, it is a relatively simple matter to determine what characteristics the motor must have in order to perform the requisite functions.

Starting Load

Figure 1 illustrates graphically the method by which a load is started and accelerated. The figure shows typical speed torque curves for both a centrifugal pump and for a conveyor. The relatively sharp hooks at the bottom of the speed torque curves indicate the breakaway torque required to originally break the bearings of the driven machine away from rest. As soon as the machine starts to turn, however, lubrication of the shaft journals becomes effective and a sudden decrease in torque requirements is shown. In this particular example, the cage motor is capable of developing approximately 105 percent of rated torque. At starting with the motor developing 105 percent torque and the pump requiring approximately 40 percent torque, obviously more torque is produced than is required to start the pump moving. Therefore, the entire difference in torque between that required to turn over the pump, and that developed by the motor is available for acceleration. In the case of the conveyor, the motor shown could not start the drive, because the requirement of the conveyor is approximately 125 percent of rated torque, while the motor will develop only 105 percent; therefore, it will not start the drive. If, however, the conveyor is given a push, manually or otherwise, so that it starts to turn and the lubrication of its bearings becomes effective, the motor then develops more than is required to keep the conveyor moving, and this machine likewise would accelerate the conveyor to its rated speed.

Effect of Rotor Impedance

The induction motor, like any other motor, produces torque by the interaction between two magnetic fields. In the

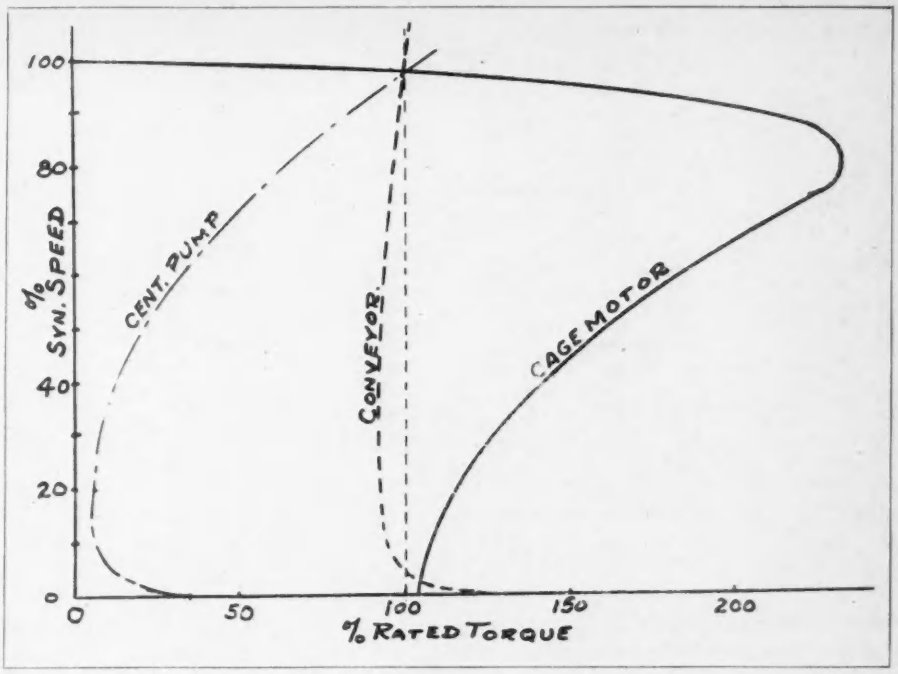

FIGURE 1

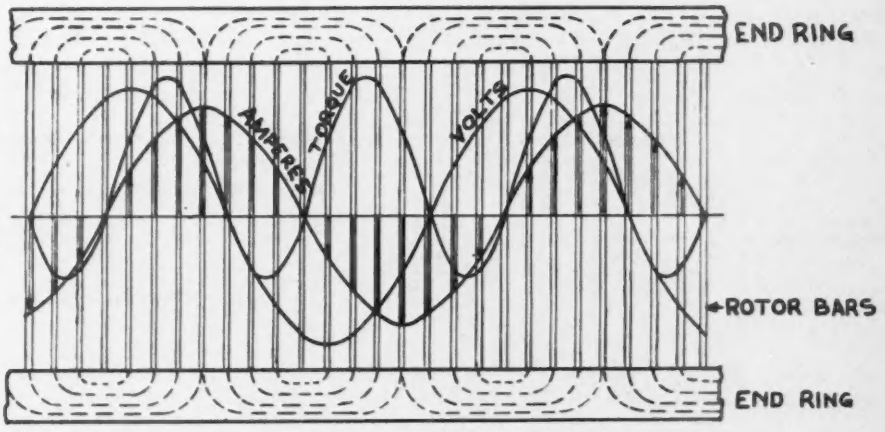

FIGURE 2. Relationship between current flow and torque in squirrel cage induction motor rotor during starting.

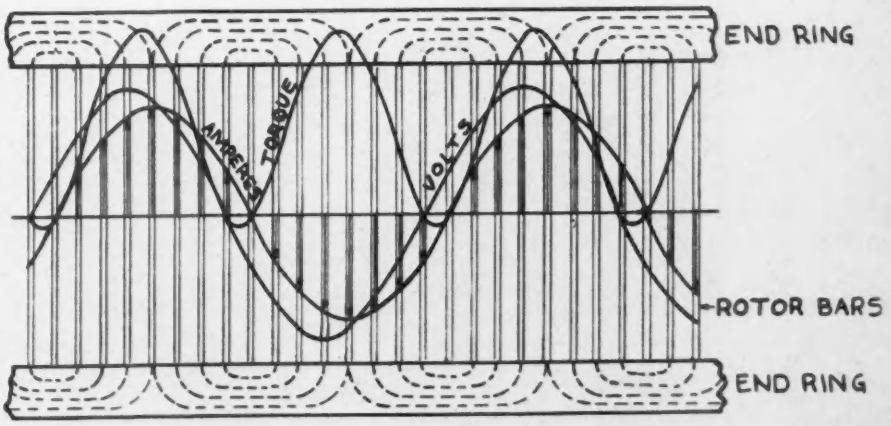

FIGURE 3. Relationship between current flow and torque in high resistance squirrel cage induction motor rotor during starting, which corresponds to insertion of external resistance in slip ring type induction motor during starting period.

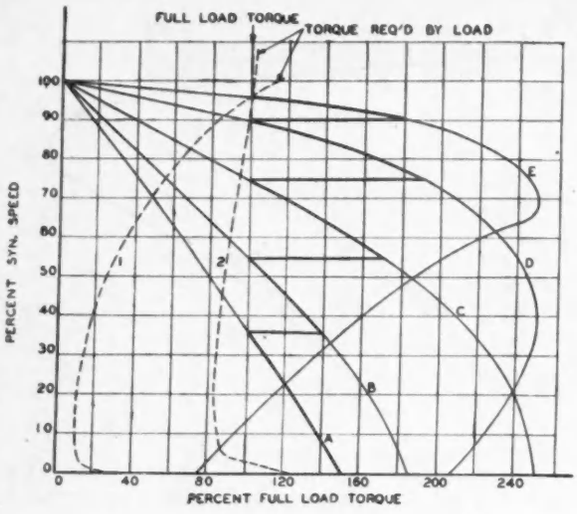

FIGURE 4

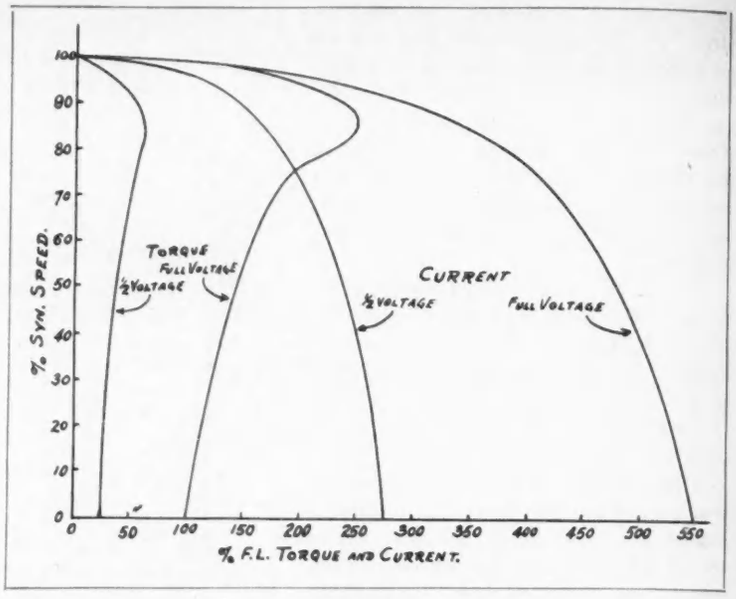

FIGURE 5

case of the induction motor, one of these fields is produced by the flow of current in the stator winding which, because of its polyphase characteristics, rotates electrically around the stator of the machine at synchronous speed. The rotor winding of the induction motor acts as the secondary of a transformer and current flows in its winding due to the induced effect of the rotating stator field, which

FIGURE 4: Speed torque characteristics of slip ring motors. Curve A—Speed torque curve with starting resistance in rotor circuit. B—Speed torque curve with 55 percent speed resistance. C—Speed torque curve with 75 percent speed resistance. D—Speed torque curve with 90 percent speed resistance. E—Full speed curve, rings short-circuited. 1. Characteristic speed curve of loaded centrifugal pump. 2. Characteristic speed curve of conveyor.

TABLE 1

Common Types of Squirrel Cage Motors . . . Electrical Characteristics and Applications

NEMA Design (1)	HP Range	GENERAL CHARACTERISTICS						Typical Application
		Locked-Rotor Torque	Break-Down Torque	Locked-Rotor Current (3)	Efficiency	Power Factor (4)	Per Cent Slip	
A	½ to 200	Per NEMA MG9-535A	Per NEMA MG9-538	Higher than NEMA MG9-523	Relatively high, even at fractional loads. Increases with speed and size of motor.	Relatively high at full load. Decreases rapidly with decrease in load. Increases with speed and size of motor.	Less than 5% (5)	
..	250 and larger (2)	4-pole, 125 to 150% 6-pole, 115 to 135% 8-pole, 110 to 125% 10-pole, 105 to 120% 12-pole, 100 to 115% 14-pole, 95 to 110% 16-pole, 90 to 105% 18-, 20-pole, 75 to 100%	Not less than 200%	500 to 700%-varies with size and number of poles.	Same as A	Same as A	2 to 4%	Same as B below.
B	½ to 200	Per NEMA MG9-535A	Per NEMA MG9-538	Per NEMA MG9-523	Same as A	Somewhat lower than A	Less than 5% (5)	Boiler feed pumps. Condenser circulating water pumps. Condensate pumps. Induced- and forced-draft fans. Cooling-tower fans. Pulverizer exhausters.
...	250 and larger (2)	2-pole, 60 to 90% 4-pole, 60 to 125% 6-pole, 60 to 115% 8-pole, 60 to 100% 10-pole, 60 to 105% 12-pole, 60 to 100% 14-pole, 60 to 95% 16-pole, 60 to 90% 18-, 20-pole, 60 to 75%	Not less than 200%	400 to 650%-varies with size, number of poles and torque required.	Same as A	Somewhat lower than A	1½ to 3%	
C	3 to 200	Per NEMA MG9-535B	Per NEMA MG9-538	Per NEMA MG9-523	Lower than A	Lower than B	Less than 5%	Coal crushers and pulverizers. Conveyors. Positive displacement pumps.
...	250 and larger (2)	From 150% and varying up to 250% for 4-pole to 160% for 20-pole	Not less than 200%	400% to 550%-varies with size, number of poles and torque required.	Lower than A	Lower than B	Less than 5%	
D	½ to 200	275% (4-, 6- and 8-pole)	225%	Not greater than NEMA MG9-523			5% or more	Cranes and coal hoists.

(1) NEMA Design Standards apply only to General Purpose ratings.
(2) No standards have been established by NEMA for ratings of 250 hp and larger, but values listed for locked-rotor and break-down torques and locked-rotor current indicate general practice.
(3) Locked-rotor current decreases with increasing number of poles.
(4) Power factor increases with increasing horsepower and decreases with increasing number of poles.
(5) May be slightly greater than 5% in case of motors with 10 or more poles.

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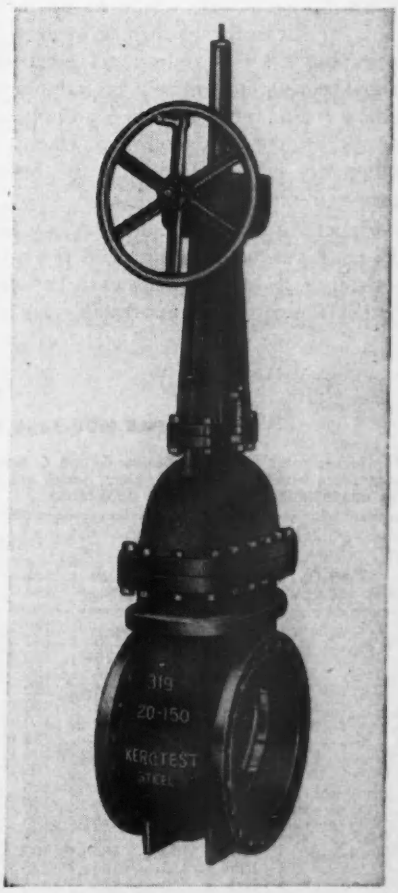

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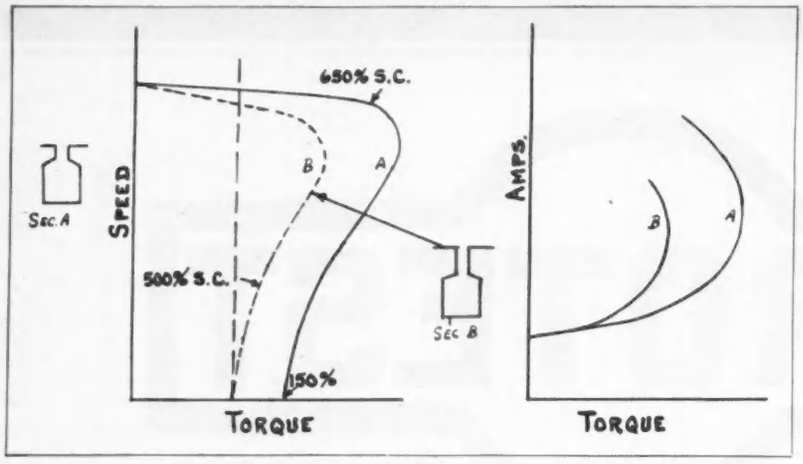


FIGURE 6

FIGURE 6A

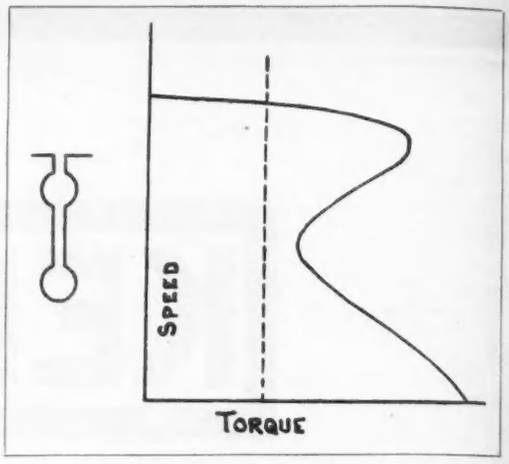


FIGURE 7

gives the machine its name of induction motor. However, in order to produce torque, there must be a reasonable phase relationship between the poles set up by the rotating stator field and those induced in the rotor field. If the position of the poles in the stator, with respect to those in the rotor, were displaced by 90 electrical degrees, the phase position would be such that no torque would be produced, since the net effective torque tending to produce rotation in the rotor would be balanced in both directions and as a net result there would be no tendency for the rotor to turn. However, it is impossible to produce an electrical circuit consisting entirely of inductance with no resistance, but this condition can be approached in a circuit in which the inductance is very high and the resistance extremely low.

Figure 2 indicates a condition in which the rotor reactance is high and the rotor resistance is low. In this case the current in the rotor will appreciably lag the voltage induced in the rotor which, of course, is dependent upon the flux produced by the rotating stator field. When such a condition exists, the torque produced, as illustrated in Figure 2, has a very definite negative component during the first half of the voltage cycle. During the latter part of the voltage cycle, when the current is in the same polarity with the voltage, the torque produced is positive and of course will tend to turn the rotor in the same direction that the stator field is revolving. It is necessary, however, to figure the net torque produced and in the condition illustrated in Figure 2 it would be necessary to subtract the negative torque from the positive torque and the net resultant torque would be the difference between these two values.

Improving Phase Relationship

If something could be done to improve the phase relationship between the current and voltage in the secondary, obviously the negative torque produced would be minimized and at the same time the positive torque would be increased. This condition can be obtained by increasing the resistance of the rotor bars, relative to the amount of reactance

TABLE 2

NEMA MG9-535A & B—Locked-Rotor Torque

The locked-rotor torque of Design B, and C motors with rated voltage and frequency applied, shall be in accordance with the following values, which are expressed in percentage of full load torque, and represent the upper limit of the range of application.

	DESIGN B								DESIGN C		
H.P. 69 Cy. / 50 Cy.	3600 / 3000	1800 / 1500	1200 / 1000	900 / 750	720 / 600	600 / 500	514 / 428	450 / 375	1800 / 1500	1200 / 1000	900 / 750
½	...	...	...	150	150	115	110	105	...	...	...
¾	...	...	175	150	150	115	110	105	...	...	...
1	...	275	175	150	150	115	110	105	...	...	...
1½	175	265	175	150	150	115	110	105	...	...	...
2	175	250	275	150	145	115	110	105	...	...	...
3	175	250	175	150	135	115	110	105	...	250	225
5	150	185	160	130	130	115	110	105	250	250	225
7½	150	175	150	125	120	115	110	105	250	225	200
10	150	175	150	125	120	115	110	105	250	225	200
15	150	165	140	125	120	115	110	105	225	200	200
20	150	150	135	125	120	115	110	105	200	200	200
25	150	150	135	125	120	115	110	105	200	200	200
30	150	150	135	125	120	115	110	105	200	200	200
40	135	150	135	125	120	115	110	105	200	200	200
50	125	150	135	125	120	115	110	105	200	200	200
60	125	150	135	125	120	115	110	105	200	200	200
75	110	150	135	125	120	115	110	105	200	200	200
100	110	125	125	125	120	115	110	105	200	200	200
125	100	110	125	125	120	115	110	105	200	200	200
150	100	110	125	125	120	115	110	105	200	200	200
200	100	100	125	125	120	115	110	105	200	200	200

The locked-rotor torque of Design D, 4-6 and 8 pole motors is 275%. This represent the upper limit of the range of application.

TABLE 3

NEMA MG9-538—Breakdown Torque

The breakdown torque of Design B, and C, 60 and 50-cycle, polyphase squirrel-cage motors, with rated voltage and frequency applied, shall be in accordance with the following values which are expressed in per cent of full load torque, and which represent the upper limit of the range of application for these motors.

HP	Synchronous Speed—rpm (60 and 50 Cycles)	Design B	Design C
½	900-750	250	...
	Lower than 750	200	...
¾	1200-1000	275	...
	900-750	250	...
	Lower than 750	200	...
1	1800-1500	300	...
	1200-1000	275	...
	900-750	250	...
	Lower than 750	200	...
1½	3600-3000	300	...
	1800-1500	300	...
	1200-1000	275	...
	900-750	250	...
	Lower than 750	200	...
2	3600-3000	275	...
	1800-1500	275	...
	1200-1000	250	...
	900-750	225	...
	Lower than 750	200	...
3	3600-3000	250	...
	1800-1500	275	...
	1200-1000	250	225
	900-750	225	200
	Lower than 750	200	...
5	3600-3000	225	...
	1800-1500	225	200
	1200-1000	225	200
	900-750	225	200
	Lower than 750	200	...
7½	3600-3000	215	...
	1800-1500	215	190
	1200-1000	215	190
	900-750	215	190
	Lower than 750	200	...
10	3600-3000	200	...
	1800-1500	200	190
	1200-1000	200	190
	900-750	200	190
	Lower than 750	200	...
15-25	All Speeds	200	190
30 and larger	All Speeds	200	190

Design D motors have no sharply defined break down torque.

which is present. Such a condition is shown in Figure 3, where the negative torque developed (when the polarity of the current is opposite that of the voltage) is minimized, while the positive torque is increased, giving a net resultant torque in the direction of stator phase rotation of very nearly a maximum value.

In effect, the torque produced is dependent upon the amount of *power* crossing the air gap. If a large amount of power crosses the air gap, this power must be absorbed somewhere. At standstill, the power output from the shaft of the machine is zero and therefore all the power going into the rotor must be absorbed electrically in its winding, or in a circuit connected to the winding. Since the major part of the life of the induction motor is usually considered to be occupied solely with running the machine, the physical size of the rotor is ordinarily not great enough to absorb a large amount of energy during the starting and accelerating period. Furthermore, after the machine has started and accelerated to speed, the high resistance rotor obviously is going to have disadvantages since the I^2R losses will be high, and the machine would have to be larger physically to produce the same output that a low resistance rotor winding could produce.

Wound Rotor Induction Motors

It would be very convenient if, during the starting period, the resistance of the rotor could be maintained at a high level, while during the running period this resistance could be kept to a minimum. Exactly that effect is obtained by the use of a wound rotor motor.

In the wound rotor motor, the rotor circuit is a phase wound connection similar to the stator winding, and slip rings are provided to allow the insertion of an adjustable series resistance in the rotor circuit. With this kind of an arrangement it is possible to start the machine with a high rotor circuit resistance, making possible the production of high torque values. Then as the motor accelerates and comes up to speed, the amount of resistance can be decreased so that in the ultimate operating condition the rotor is short circuited and for all practical purposes operates as a squirrel cage motor. The method of operation is illustrated in Figure 4.

Curve A indicates the condition during starting in which the maximum resistance is inserted in the rotor circuit. Under such conditions, the machine will accelerate along Curve A, and, if the load required no torque beyond accelerating torque, the machine ultimately would run up to synchronous speed. Note, however, that on this curve are indicated two typical load-torque curves, No. 1 representing a typical curve for a centrifugal device, such as a pump or a fan, No. 2 showing the typical characteristics for a constant torque load such as a conveyor. At starting, the motor, as indicated by Curve A, will develop approximately 150 percent torque which is sufficient to start either of the two loads. As the motor accelerates however, its torque output decreases, so that where Curve 2 and Curve A cross, the motor would be producing just enough torque to keep the machine operating at roughly 45 percent speed, and could not accelerate this machine further. In the case of the fan curve, however, it would accelerate to approximately 70 percent speed but could not develop sufficient torque to drive this machine to a higher speed. It would then be necessary to reduce the amount of secondary resistance (transferring the characteristics to curve B) which would accelerate the conveyor to approximately 50 percent speed. Then by operating on curves C, D, and E in succession, the machine could be accelerated to its full operating speed.

Note that in the final running position as illustrated on Curve E, the starting torque is reduced to approximately 75 percent. This amount of torque would not be sufficient to break the conveyor loose from rest, although it would be more than adequate to start the centrifugal pump. Such starting, however, would be accompanied by a very high current inrush from the line.

It is apparent, then, that the wound rotor motor is ideal for starting and accelerating purposes. However, it is a relatively expensive machine, and its control is much more expensive than that which is normally applied with the squirrel cage motor. On the basis of economy then, it is advantageous to investigate the use of the squirrel cage motor whenever applicable.

Starting Current

Besides the production of an adequate amount of torque, serious consideration must be given to the amount of current drawn by the motor during the starting period. In the case of the wound rotor motor (since the rotor resistance is relatively high at starting) the amount of current drawn is relatively small. In fact, during the starting period of a wound rotor motor the amount of current drawn is almost directly proportional to the amount of torque developed. That is, if we must develop 150 percent starting torque, this amount can be obtained by drawing approximately 150 percent of rated current from the line. This condidition of course is directly dependent upon the fact that the resistance of the rotor circuit is a major component tending to restrain the flow of current.

In any induction motor, the items of

TABLE 4

NEMA MG9-523—Locked-Rotor Current 3-Ph, 60-Cy, 220 Volts

Locked-rotor current, measured with rated voltage and frequency, shall not exceed the following values.

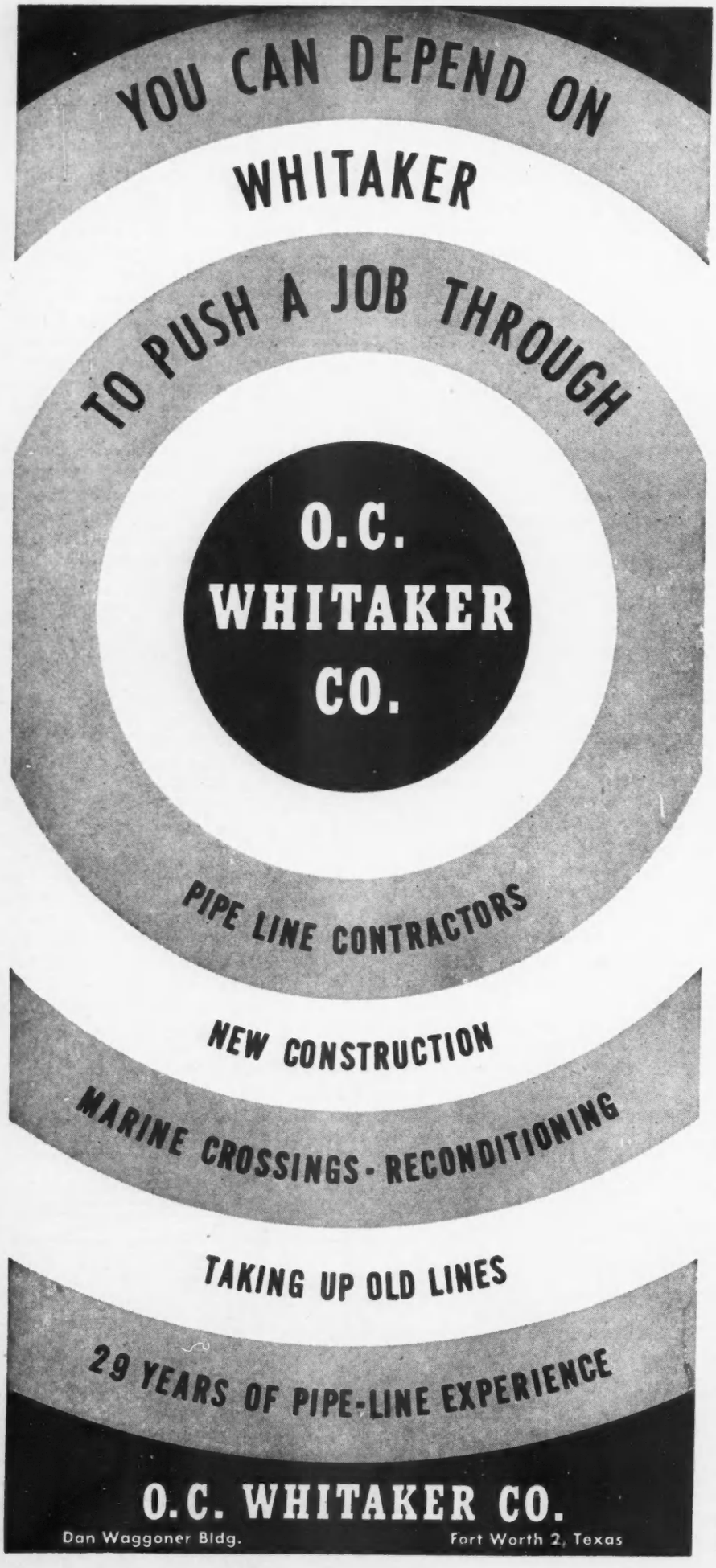
Rated H.P.	Amperes Design B, C & D
1	24
1½	35
2	45
3	60
5	90
7½	120
10	150
15	220
20	290
25	365
30	435
40	580
50	725
60	870
75	1085
100	1450
125	1815
150	2170
200	2900

Locked-rotor current at other voltages is inversely proportional to the voltage.

TABLE 5

Effect of Change in Frequency or Voltage on the Operation of General Purpose Induction motor

	GENERAL PURPOSE—Class A (Type AR)			
	Voltage (In Percent of Rated)		Frequency (In Percent of Rated)	
CHARACTERISTIC	110%	90%	105%	95%
Torque				
Starting and Max. Running	Increase 21%	Decrease 19%	Decrease 10%	Increase 11%
Speed				
Synchronous	No change	No change	Increase 5%	Decrease 5%
Full Load	Increase 1%	Decrease 1.5%	Increase 5%	Decrease 5%
Percent Slip	Decrease 17%	Increase 23%	Little change	Little change
Efficiency				
Full Load	Increase 0.5 to 1	Decrease 2	Slight increase	Slight decrease
¾ Load	Little change	Little change	Slight increase	Slight decrease
½ Load	Decrease 1 to 2	Increase 1 to 2	Slight increase	Slight decrease
Power-factor				
Full Load	Decrease 3%	Increase 1%	Slight increase	Slight decrease
¾ Load	Decrease 4%	Increase 2 to 3%	Slight increase	Slight decrease
¾ Load	Decrease 5 to 6%	Increase 4 to 5%	Slight increase	Slight decrease
Current				
Starting	Increase 10 to 12%	Decrease 10 to 12%	Decrease 5 to 6%	Increase 5 to 6%
Full Load	Decrease 7%	Increase 11%	Slight decrease	Slight increase
Temperature Rise	Decrease 3 to 4° C.	Increase 6 to 7° C.	Slight decrease	Slight increase
Maximum Overload Capacity	Increase 21%	Decrease 19%	Slight decrease	Slight increase
Magnetic Noise	Slight increase	Slight decrease	Slight decrease	Slight increase



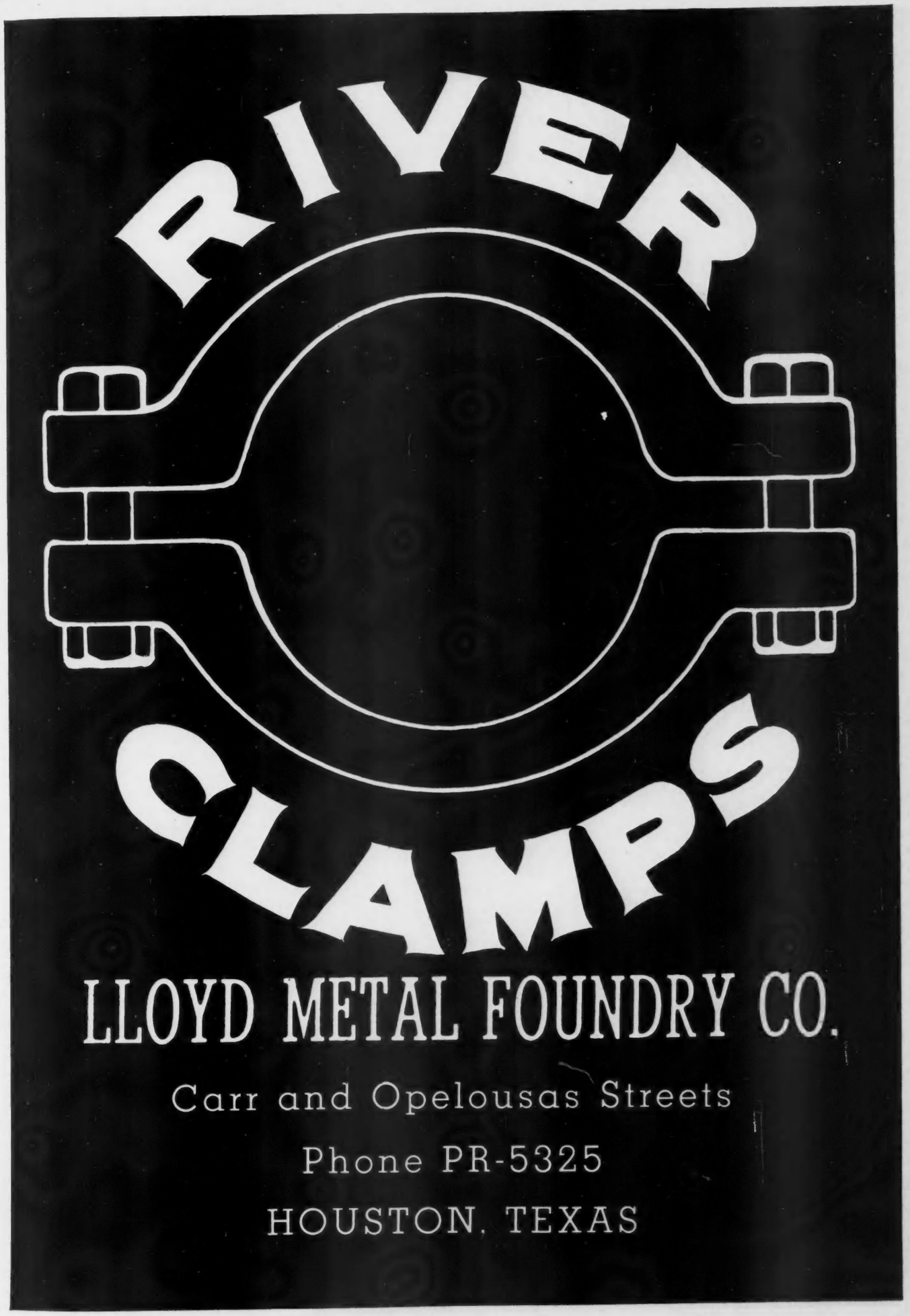
resistance and reactance jointly affect the amount of current that will be taken at starting. If either of these two items is increased, the current drawn from the line at starting will be decreased for a given applied voltage. We must bear in mind, however, that an increase in resistance, while it will result in increased starting torque, will increase the rotor losses, and probably will result in a machine of larger physical size than a comparably rated machine having low resistance rotor winding. Obviously, these relatively high rotor losses with a high resistance rotor have a serious effect on the running efficiency of the machine.

Because of all of the above considerations, the ultimate goal in the design of a squirrel cage motor is to produce a machine with sufficient starting torque to start, and sufficient accelerating torque to accelerate the load to speed with a minimum practical starting current.

Some driven machines, particularly those which follow a fan characteristic, require relatively light starting torque, usually about 25 to 40 percent. Furthermore, immediately after the bearings are broken loose from rest, the torque demand drops appreciably, remaining small until the machine is pretty well up to speed. Therefore, a motor which is primarily intended for fan service can be built with relatively high reactance to cut down the inrush and a relatively low resistance, since the starting torque demand is not severe.

Importance of Starting Current

The matter of starting current is of such concern that it might be well to illustrate a little more clearly just what happens to the current while the motor is starting and accelerating. Figure 5 shows typical current-speed curve and speed-torque curve drawn to the same scale. From this figure, it may be seen that the current at full voltage at starting is 550 percent of rated current. This current does not decrease materially until the motor is up to almost 70 percent speed, at which time it decreases rapidly so that over the operating range of the machine, that is, from no load to 100 percent load, the current is roughly proportional to the torque developed. Probably the most common means of reducing the inrush current is the use of reduced voltage starting. However, it must be borne in mind that when the applied voltage is reduced, not only the current but also the torque developed by the motor is decreased. Furthermore, while the current is reduced in direct proportion to the applied voltage, the torque developed is reduced in the ratio of the square of the applied voltage. For example, starting on an 80 percent voltage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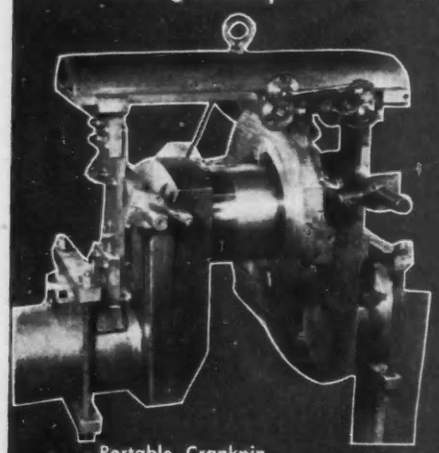

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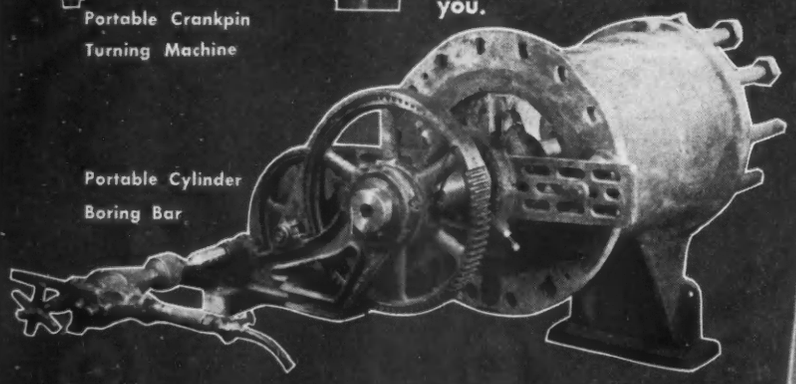

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tap, the current is reduced 20 percent, while the torque is reduced 36 percent of its value at full voltage.

A certain amount of flexibility in torque and starting current can be obtained by altering the design of the rotor of a squirrel cage motor.

Figure 6 shows the effect of changing the imbedded depth of the rotor bars. Section A shows a rotor bar which is relatively shallow. This, of course, means that the flux encircling this bar encounters a considerable air gap, and for that reason the reactance of this unit is relatively low. Section B shows the same size slot, except that it is imbedded deeper into the body of the rotor giving a greater sectional face to the air gap, increasing the inductance of this particular rotor bar. The effect on the torques is as indicated on the characteristic speed torque curve. Section A provides a starting torque of 150 percent with a starting current of 650 percent while Section B gives approximately 100 percent starting torque with 500 percent inrush. The manner in which the amperes vary with the torque, as the machine comes up to speed, is indicated by Figure 6A. These two characteristics, of course, are based on the assumption that the resistances of the two rotor windings are identical.

The design of the rotor bars can be carried further, as is indicated in Figure 7. By using a rotor made up of two separate sets of bars, the reactances and resistances of the individual windings can be modified to suit the required condition. For example, in the upper bar in Figure 7, the reactance is fairly low while the resistance is made high, while the reactance of the lower bar is high and the resistance is low.

As the motor starts up from rest, the frequency induced in the rotor, of course, is line frequency. Since the reactance varies with the frequency, obviously the lower winding will offer considerable impedance to the flow of current, since its reactance is high, while the upper ring, with low reactance, will carry a very large percentage of the total induced current.

As the speed of the rotor increases and approaches synchronous rotative speed, the frequency of the current in the rotor windings decreases, and with this decrease in frequency the reactance likewise decreases. Under these conditions, the low resistance winding takes an increasingly greater share of the current and because of the interaction between these two windings the speed torque curve of such a machine is actually a composite curve, made of the combined characteristics of both the cage windings. A typical example is shown in Figure 7.

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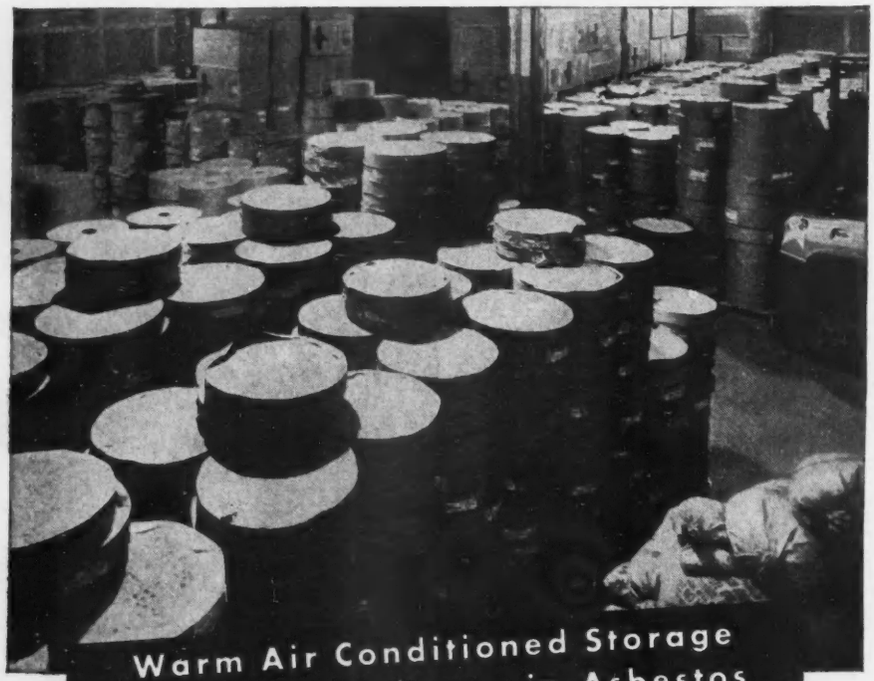

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ing is the deep bar type, as indicated in Figure 7A. In the case of such a deep bar, the current is concentrated at the outside end of the bar during the time that the frequency of the rotor is high and current gradually distributes itself over the entire section of the bar as the frequency decreases. This characteristic gives us a curve as shown in Figure 7A.

Standardization of Induction Motors

The National Electrical Manufacturers Association, more commonly referred to as NEMA, has prepared standards for squirrel cage motors, as well as other electrical machinery. The degree of standardization of squirrel cage motors is illustrated in Table 1. From a study of this table, it is shown that there are four standard classifications of motors, the classification depending mainly on the starting current and starting torque of the particular unit involved. In this table NEMA Design D is a high resistance rotor machine, which obviously will give us high starting torques. Because of that fact, these machines are usually intermittent rated, since continuous operation with high rotor losses would mean that the temperature of the rotor would become excessive, unless an oversized machine were used.

In the table, reference is made to certain NEMA standards. The standards indicated as being applicable to the machines in this table are illustrated in Tables 2, 3 and 4.

Very often the question of operating a motor at other than its name-plate voltage, or name-plate frequency arises. The possible effect of a change in frequency or voltage on the operation of the machine is illustrated in Table 5. This table is self-explanatory.

Conclusion

The application of induction motors, particularly squirrel cage motors, to anything other than normal industrial drives usually is a compromise betweeen several desirable characteristics. It is not possible to obtain optimum characteristics of all types on the same motor for most applications. For example, if high efficiency and high power factor during the operating period are required, some sacrifice must be made in the amount of starting current, or the amount of starting torque, or both. Vice versa, if very high starting torque with low starting current is required, there must be some sacrifice made in the way of power factor or efficiency. When we further inject the question of first cost into the problem, it becomes still more complicated, and for that reason, it is usually recommended that an engineer experienced in the application of machines be consulted to determine the most feasible and economical choice of machines.

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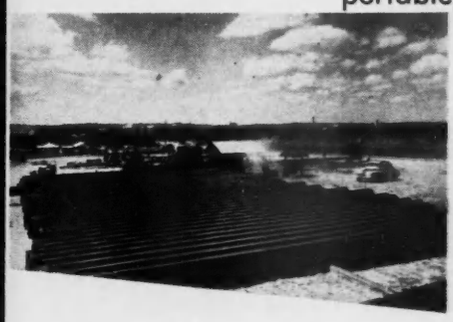

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Remote Control

For Compressor Station Manifold

By ELTON STERRETT
Engineering Editor

To guard against the remote possibility of fire within or adjacent to a trunk line gas compressor station, it is essential that means be provided for closing both ends of the main line, so as to prevent continuing delivery of gas from the next preceding station, as well as blow-back from the pressured line leaving the station.

Location of block gates can not be too far away from the station, or the time element may permit the fire to get out of control and complete loss of the station result. Neither, for manually operated closures, can the valves be set too close to the compressor building, as the fire then may render it impossible for personnel to remain at the valves long enough to effect closure. A set of block gates and vent at the compressor station near Fagus, Mo., on the twin lines of the Texas Eastern Transmission Corporation, meets all the requirements for instantaneous and safe operation. The closures are located immediately adjacent to the compressor building, and thus are available for normal operational use when required in putting a station on or removing it from the line.

In addition to the manual operation of the gate operating mechanisms, there is provided a gas-pressured system with remote control. The pressure tank for operating the closures, as well as the unit whereby the system is activated, is located well away from the compressor building, and close to the house in the station camp which is occupied by the station chief engineer. To operate all the necessary valves, it is necessary only to open one valve and put the 275-pound pressure within the storage tank on the lines to the various valve operating mechanisms.

Two Valve Types

Two types of valves are used. The suction line to the station, branching off from the 24-inch main or trunk line, is of the plug type, and requires only a quarter-turn of the valve to effect complete closure. Since a motor to exert sufficient torque to turn this valve quickly would be unduly large, a small pinion is keyed to the valve stem, and meshed with it is a rack connected to the piston of a hydraulic cylinder. Travel limits of this piston are such as to complete the opening or closing cycle of the valve. The oil actuating this piston is stored in a vertical, above-ground tank adjacent to the valve setting. The pressure line from the remote tank enters this storage unit at the top, forcing the oil out through the pipe at the bottom and thence into the hydraulic cylinder mounted on the valve closing unit. Ample oil is carried in the storage unit to insure complete closure of the main valve.

The station discharge valve, tying in the high-pressure manifold to the main line, is of the gate type, with a closing cycle of more than 200 turns on the hand wheel. This valve is spun shut by an air motor built onto the operating gearing, and driving through a torque-limiting unit to avoid jamming the gate in the closed position or overstressing the gear train. This valve requires substantially more time for closing than does the plug valve on the suction side of the station; therefore, it allows for displacement of any high-pressured gas passing through the compressors at the instant the safeguard is actuated.

A similar gate valve ties in the bypass on this dual system whereby pressure is equalized between the 24 and 20-inch main lines. This valve is also cut off before the main discharge gate is spun shut.

To vent the lines within the station area which are filled with high-pressure gas at the time the control valves are operated, a stub vent line and control valve are tied in to the system so that

FIGURE 1. To give rapid closure of the suction line into the compressor station, this quarter-turn plug valve is cylinder operated, with gas pressure acting through store oil to give positive hydraulic power on the rack and gear. Tank in right foreground is oil for pressure system, with try-cocks for gauging.

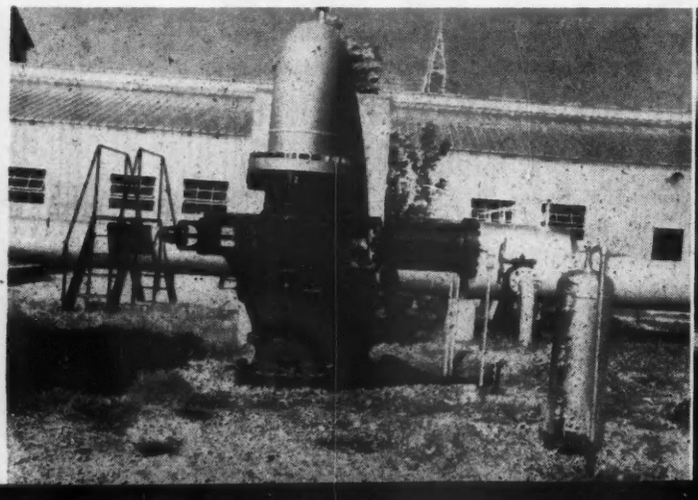
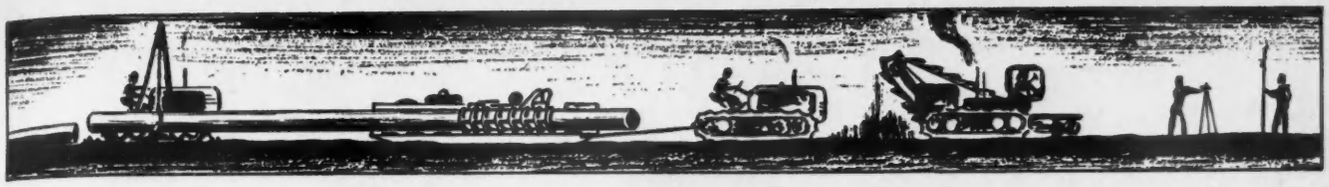


FIGURE 2. The valve at the right is the station discharge line, while the smaller unit at left center is the bypass closure to effect seal between the two lines leaving station. Hand wheel on station discharge permits routine closure without involving emergency shutoff equipment. Buried pressure lines prevent hydrate blocking.



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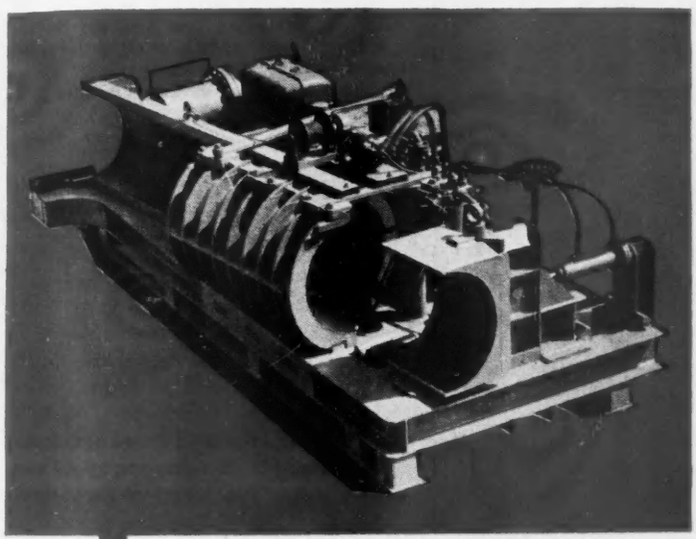
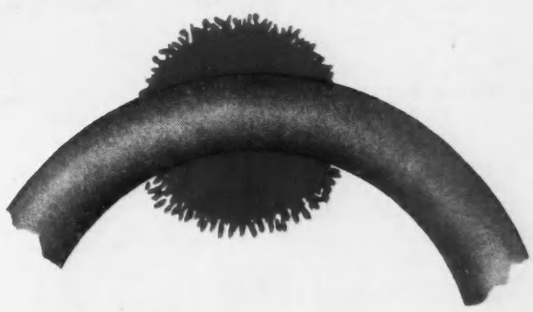
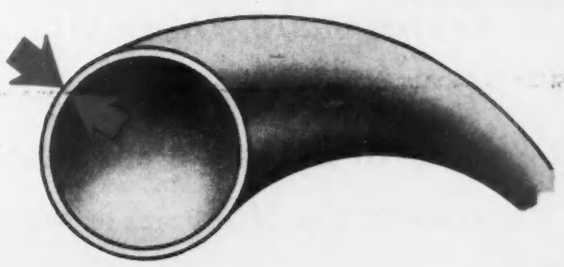


The Cinch Bender, a pipe bender that handles pipes up to 30" O.D. right on the job, saves you time, money and labor without effecting roundness or wall thickness of pipe. What's more, engineering and laboratory tests prove bends made by the Cinch Bender have improved yield and tensile strength. The Cinch Bender eliminates costly kinking and also eliminates the starting and stopping of machines so that cleaning and priming, doping and wrapping become one continuous operation. The Cinch Bender gives the owner the pipe line he desires —gives the contractor better production methods. Write for engineering details.

Bends pipe so that original strength is maintained or improved and pipe remains smooth and full-formed.



Wall thickness and roundness of pipe keep within the specifications for new straight pipe.



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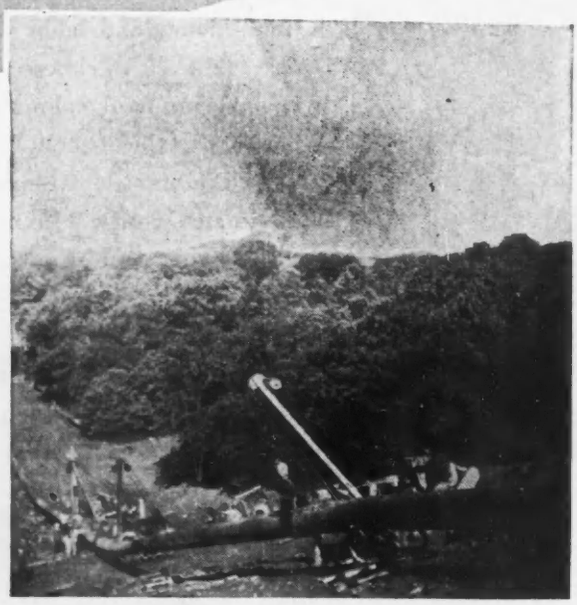

Scenes along 124 miles of 26 inch pipe line constructed in Ohio.

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A. L. FORBES, JR., President — EARL ALLEN, Vice-President

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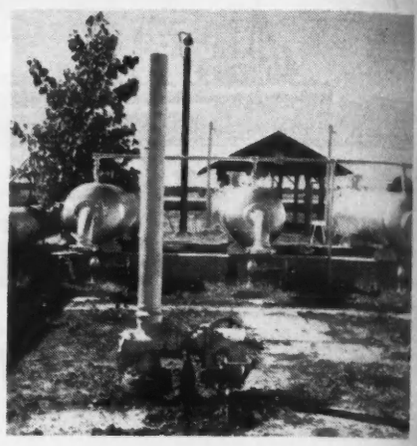

FIGURE 3. Valve and vent pipe are operated in sequence with suction and discharge line closures to vent station manifolds of all gas. This prevents build-up of high pressures in the station equipment or lines.

the line leading to the discharge side of the manifold can be relieved of pressure and the possibility of excess pressure within the line thus eliminated. This valve is also air-motor operated, and, being of smaller size than either of the two valves used to close off the flow of gas from the station into the main, will be opened the instant the discharge valve is fully closed. This is a sequence operation and is necessary to avoid venting gas other than that confined in the station manifold piping.

Since gas under pressure is available at the station at all times, enough gas is bled from the line to maintain the control operating system pressure tank fully charged at the operating pressure of 275 pounds, gauge. The lines from tank to the various valve operating units are one-inch steel pipe, and are buried below the frost line between tank and points of attachment to the operating units to avoid danger of freezing or hydrate forming. These lines are not maintained full of gas at all times, but the system is tested periodically to eliminate the possibility of its not functioning in case of emergency.

A set of three try-socks, set into the side of the oil-storage tank for the hydraulic system for the plug valve on the suction side, enables the amount of oil within the tank to be accurately determined. A short nipple and valve set into the top of the tank provide for refilling of the tank or adding any make-up oil which may be required. The oil in the tank is simply displaced by gas when the plug valve is to be closed, and returned to the tank when the plug valve is again opened. The rack forces the hydraulic piston to the outer end of the operating cylinder. Gas is vented from the oil-storage tank through the same valve which is used for replenishing the oil stock within the tank.

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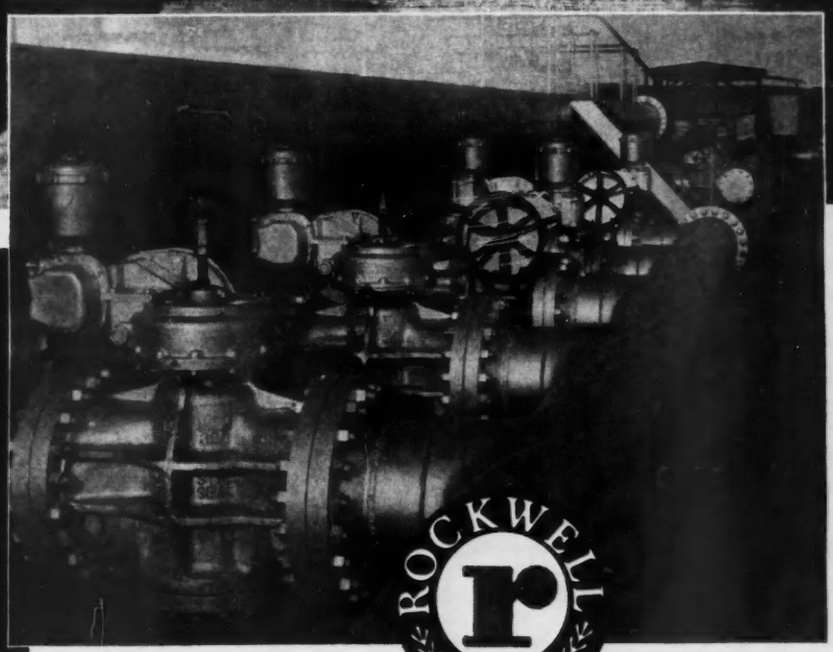

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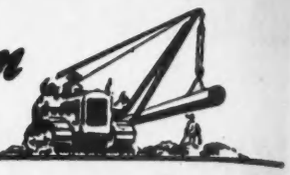
PIPE LINE *Construction*



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CRUDE OIL LINES					
Interprovincial Pipe Line Co. Ltd.	Edmonton, Canada to Superior, Wisconsin	1150	16–18–20	95,000	Proposed line has been approved by Board of Transport Commissioners. Construction to the border will be completed in 1950, and to U. S. terminal in 1951.
Mid-Valley Pipeline Company	Haynesville to Lake Providence, Louisiana	120	20	.....	Preliminary work on main line section started Sept. 6.
	Delhi to Lake Providence, La., Lateral line	41	12	.....	Pipe laying on main and lateral to start in early Nov.
	Mississippi River Crossing, Lake Providence	.....	Two-20	.....	by Latex Construction Co., Houston. Latex began river work in Oct.
	Hebron, Kentucky to Eaton, Ohio	60	20	.....	Britton Construction Co., Ft. Worth, started laying pipe on this section in Oct.
	Eaton, Ohio to Lima, Ohio	60	20	.....	Construction on this leg was begun in Oct. by Mahoney contracting Co., Mt. Pleasant, Mich.
Plains Pipe Line Company	Mush Creek fld. to Lance Creek fld., Wyoming	50	8	20,000	Completed in Sept. by A. W. Hartwig, Inc., Billings, Mont.
Simrall Pipe Line Company	Rosebush fld. to Mt. Pleasant, Michigan	8	6	.....	Being built by Somerville Construction Co., Ada, Mich.
PRODUCT LINES					
Standard Oil Company (Ohio)	Toledo to Fostoria, Ohio	38	8	.....	The Britton Construction Co., Hamilton, Ohio, started Oct. 10 and will complete in early Dec. Line will cost $700,000 and is being laid parallel to present 6-in. line.
Stanolind Oil & Gas Company	Company's gasoline plant, Fullerton fld., W. Tex. to Eunice, New Mexico	19	6	.....	This line built to carry liquid butane was completed early in Oct. by Deaton & Sons, Inc., Odessa, Texas.
Great Lakes Pipe Line Company	Des Moines, Iowa to Minneapolis, Minn.	260	12	6,500	Contracts for this line as follows: O. R. Burden Const. Corp., Des Moines to Williams, Ia., 64.63 miles; A. C. Holder Const. Co., Williams to Albert Lea, Minn., 72.33 miles; Sheehan P. L. Const. Co., Albert Lea to St. Paul, 103.61 miles; Williams Bros. Corp., St. Paul to Minneapolis and Miss. River crossing, 19.6 miles. All are Tulsa firms and were scheduled to start construction in Mid-Oct.
	Irvington, Nebraska to Sioux Falls, South Dakota	165	12	.....	This newly proposed line is in addition to the recently announced 976-mile expansion program, of which the above section is a part. This latest project would cost $7,900,000 and would also include enlargement of 4 delivery terminals, increased power at two stations and one new pump station.
NATURAL GAS LINES					
Central New York Power Corp. & New York Power & Light Corp.	N. Y. State Nat. Gas Corp.'s line on Otisco-Onondago town line to Central's system, Syracus, N. Y.	16	.....	4.1 mln	Application to FPC for facilities to distribute gas in Oswego, Onondago, Madison, Oneida, and Herkimer Counties.
Cities Service Gas Company	Hugoton fld., Kansas to Kansas City, Missouri	400	26	267 mln.	Dedication services were held Oct. 12 upon completion of final section of this major gas line. Ray L. Smith & Son, Inc., El Dorado, Kan., Midwestern Constructors, Inc., Tulsa, and R. H. Fulton & Co., Lubbock, Tex. were contractors. Construction was begun in 1947.
Colorado Interstate Gas Company	Loop near Denver on Hugoton to Denver line	38	20	62 mln.	Cheek Const. Co. Inc., Ulysses, Kan. started Sept. 25. Project includes additional 3600 hp at Lakin Sta. (Hugoton) and new 8400 hp sta. near Kit Carson, Colo.
	Loop near Lakin, Kan. on Hugoton to Denver line	15 3/10	20	.....	Job which includes an Arkansas River crossing was started in Oct. by R. H. Fulton & Co.
Consolidated Gas, Electric Light & Power Company	Baltimore, Maryland, vicinity	14	26	.....	Pipe Line Construction & Drilling Co., Camphill, Pa., has job underway.
El Paso Natural Gas Company	Benedum fld., to company's Keystone Sta., W. Texas	95	24	25 mln.	Completed in October by company crews.
Hugoton Production Company	Cimarron River crossing at Hugoton fld., Kansas	....	22	.....	Completed by Trojan Const. Co. Inc., Okla. City.
Interstate Natural Gas Company	Vicinity west of Baton Rouge, Louisiana	29	16–20–22	.....	Latex Construction Co. completed job in October.
Iowa-Illinois Gas & Electric Co.	Oskaloosa, to Ottumwa, Iowa	25	4	.....	Being laid by T. & L. Construction Co., Centralia, Ill.
Jersey Central Power & Light Company	TETCO's "Inch" line at Bound Brook to company's gas mfg. plant, Long Branch, N. J.	39 1/10	10	.....	FPC authority granted.
Kansas-Colorado Utilities, Inc.	Kendall to Syracuse, Kansas, lateral line	21	4 & 6	.....	Lateral and gathering lines completed by S. C. Patterson, Phillipsburg, Kansas.
	Gathering system ,Hugoton fld., near Kendall	9	.....	.....	
Michigan Consolidated Gas Co.	Austin fld. to Goodwell fld., Michigan	15	20	.....	Completed Sept. 20 by Somerville Construction Co.
Michigan-Wisconsin Pipe Line Company	Crown Point, Ind. to Big Rapids, Michigan	180	22	.....	Section of Tex. Panhandle-to-Mich. line completed in Oct. by Oklahoma Contracting Co. Inc., Dallas.
Mississippi River Fuel Corporation	Granite City to E. St. Louis, Illinois	9½	20 & 24	.....	Job underway by Sheehan Pipe Line Construction Co.
	Three compressor stations on Louisiana-St. Louis line	....	.....	.....	Application to FPC asks for 3 stations of 13,000 hp in Ark., La., Mo., and additional 3000 in authorized stations
Mountain Fuel Supply Company	Coalsville to Salt Lake City, Utah	32	20	23.6 mln	Project costing $1¾ million was completed Sept. 15 by Enoch Smith Sons Co., Salt Lake City.
Northwestern Utilities Ltd.	Uncas to Edmonton, Alberta, Canada	17 1/10	16	.....	Scheduled for October completion.
The Ohio Fuel Gas Company	Underground storage project in Medina, Lorain, Richland and Hocking Counties, Ohio	59 8/10	.....	.....	Authorized by FPC. Existing well and fld. lines totaling 53 miles will be retired.
	TETCO's "Inch" lines near Carroll to Columbus, Ohio	27	20	140 mln	Completed by Mahoney Contracting Co.
Oklahoma Natural Gas Company	Vicinity of Wetumka, Oklahoma	10	10	.....	Both underway in Oct. by Western States Construction Co., Inc., Oklahoma City.
	West Edmond fld., Oklahoma	8	10	.....	

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Pipe Line Construction—Continued

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Pacific Gas & Electric Company	Gathering system, Durham fld., Butte Co., California	6½	4 & 6	.....	Constructed by M. G. M. Const. Co., Concord, Calif.
Phillips Petroleum Company	Gathering system near Edmond, Oklahoma	25	.....	.....	Vaughn & Taylor Construction Co. Inc., Wichita Falls, started job Sept. 19.
Southern Counties Gas Company	Ventura to Carpinteria, California	12	20	.....	Line being laid by J. E. Young Pipe Line Contractor, Inc., Los Angeles.
South Mississippi Electric Power Association	Baxterville fld. to Hub fld., Marion Co., Mississippi	10	.....	13 mln.	Proposed project to supply fuel to REA power plants.
Tennessee Gas Transmission Company	Greenville to Ruleville, Mississippi, Loop	50	30	.....	Completed in Sept. by H. C. Price Co., Bartlesville, Okla.
	Vicinity of Bay City, Upper Tex. Coast, Lateral	42	8 & 16	.....	Sheppard-Geiger Construction Co., Corpus Christi, has job underway.
	Natchitoches, Sta. No. 5 to Monore, La., Sta. No. 6. Loop	24⅔10	30	.....	Application to FPC also includes addition of 4830 hp at Sta. No. 5.
	Vicinity of Eagle Lake, Upper Tex. Coast. Lateral	21	12	.....	Underway by Massey Pipe Line Construction Co., Corpus Christi.
Texas Gas Transmission Corporation	Carthage fld., Tex., to Red River near Curtis, La.	40	20	.....	Fowler Bros., Cotton Valley, La., sub-contracted from N. A. Saigh Co., San Antonio, prime contractor of 100 miles on Tex.-Ohio line. Work on 40-miles started in Oct.
	Sharon, La. to Mississippi River near Lake Village, Ark.	101	26	.....	Latex Construction Co. was scheduled to complete Oct. 10.
	Red River crossing near Curtis, La.	....	Two 16	.....	Latex started in October.
	Fulton to Slaughters, Kentucky	103	26	.....	To be completed Nov. 1 by Oklahoma Contracting Co. Inc.
	Garrett, Ky. to Ohio River	76	26	.....	Williams Bros. Corp. was scheduled to complete Oct. 15.
Transcontinental Gas Pipe Line Corporation	Hudson River terminus to N. Y.-Connecticut border	36	20 & 24	100 mln	This extension would deliver to a planned line in Conn. for distribution in New England. Included in FPC application is plan to substitute 362 miles of 30-inch pipe for 26-inch, raising authorized daily capacity of 340 mln. to 505 mln. 10 new stations of 137,120 hp. would be installed. This project would cost over $50 mln.
United Gas Pipe Line Company	Baxterville fld., Lamar Co., Miss. to Mobile Jct. Ala.	90	20	100 mln.	Both jobs completed in Oct. by O. C. Whitaker Co., Ft. Worth.
	Gathering system in Baxterville fld.	9½	.....	.....	
	Church Point, to Opelousas, Louisiana	12	6	.....	Job started by Murray Construction Co., Shreveport, and includes take-up of 12 miles of 4-inch.
United Natural Gas Company	Pugh Station to Siegel, Pennsylvania	13½	12	.....	Northeastern Construction Co., Harrisburg, Penna., is laying line.

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General Contractors

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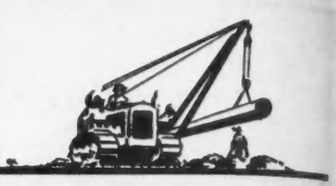
PIPE LINE HINTS



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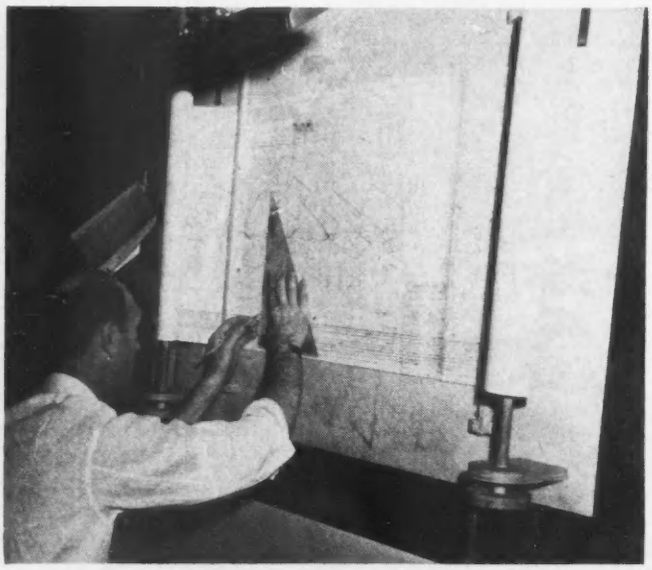
It is as important for the division office to maintain construction progress records on pipe line projects as it is for the central office, even though the running record of the field office may not be as elaborate and detailed. The field superintendent and engineers, charged with complete construction responsibilities, must know from day to day what is going on along the line. It is difficult in many cases for the superintendent to make a complete check of all operations down the line, so he receives daily reports from his inspectors and from the subcontractors on what has been accomplished during the previous day.



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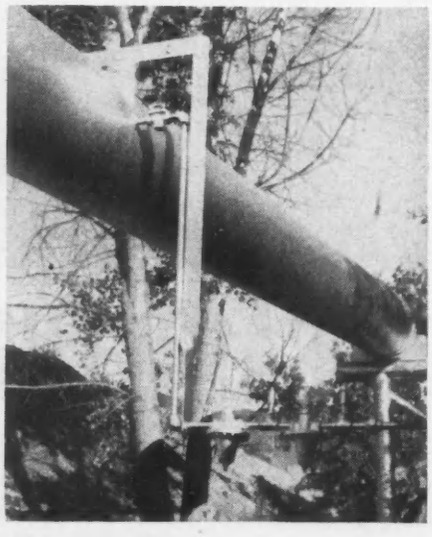
Each end of this long map was attached to a wooden axle which had been mounted on a piece of plywood and hung on the wall. Only about four feet of the strip map is exposed at one time, but by rolling either end with a crank connected to the axle, any segment along the line could be inspected.

A series of different colored lines was adopted to correspond to the various phases of pipe line construction. Red was used to indicate acquisition of right-of-way, blue for surveying, yellow for clearing, etc. From the daily reports received on construction progress, the colored lines could be extended along the bottom of the map to the actual point at which any particular phase had progressed. A quick glance gives the observer the current progress on all phases of construction without referring to letters or to tabular sheets.

HOW TO—Prevent Breakage of Small Fittings

When small pipe fittings and valves are connected into a larger pipe line, danger always exists that they may be broken as a result of careless handling or accidental bumping by passing machinery. An arrangement that eliminates much of this danger was worked out by one pipe line superintendent when a small domestic line had to be taken off the side of a large diameter high-pressure gas line, and at a point where the large carrier spanned a shallow ravine.

Prior to assembling the smaller line, welders built a reinforcing structure of three-inch flat steel bar which was attached to the large line in the manner shown. The bar was brought down vertically beside the small line, and at the point where the latter was turned into the horizontal run, the bar was twisted about its own axis through 90 degrees. A hole of sufficient diameter to allow passage of the smaller pipe was burned through this part of the flat bar, after which the pipe was run through it and made up.



The protective bar lends rigidity to the smaller line, and protects it from breakage when struck by a blow originating from a point on a line normal to the axis of the main line. Any force traveling parallel to the main line, while being able to bend the flat bar slightly, nevertheless would tend merely to twist the vertical pipe in one or other fittings near the top of the assembly adjacent to the small valve.

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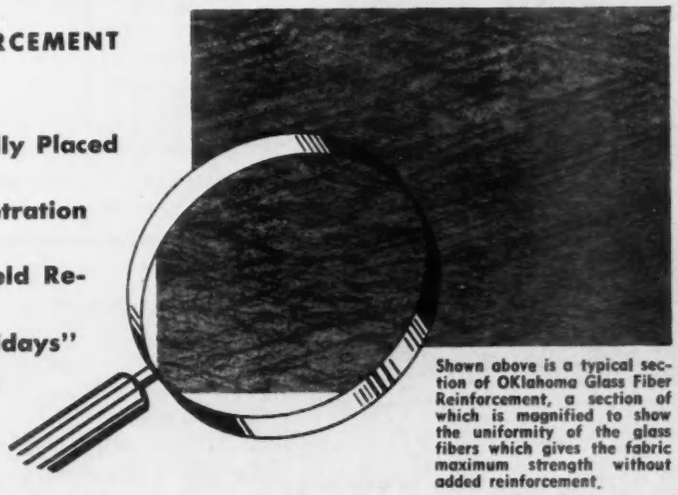

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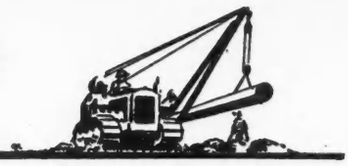

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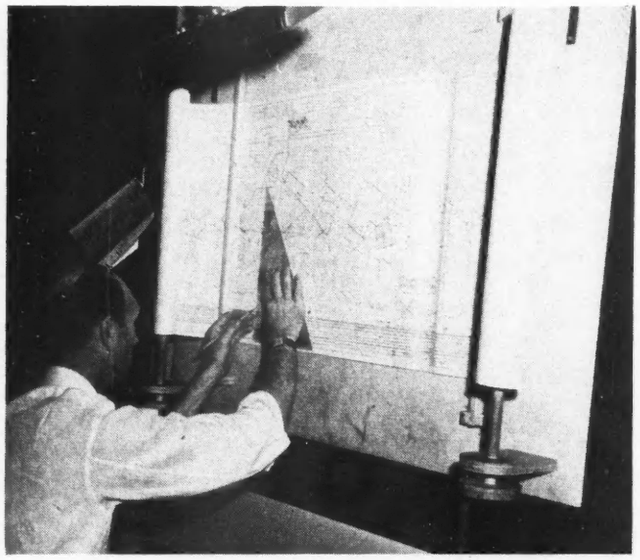

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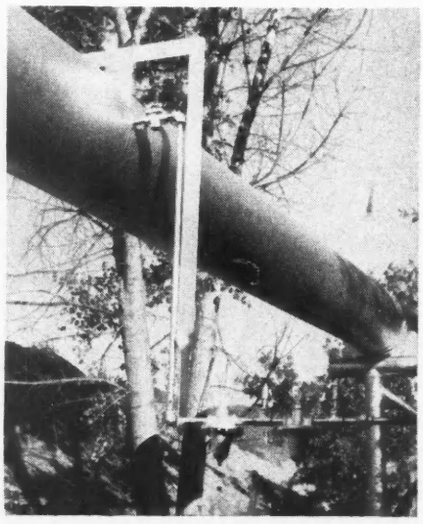
When small pipe fittings and valves are connected into a larger pipe line, danger always exists that they may be broken as a result of careless handling or accidental bumping by passing machinery. An arrangement that eliminates much of this danger was worked out by one pipe line superintendent when a small domestic line had to be taken off the side of a large diameter high-pressure gas line, and at a point where the large carrier spanned a shallow ravine.

Prior to assembling the smaller line, welders built a reinforcing structure of three-inch flat steel bar which was attached to the large line in the manner shown. The bar was brought down vertically beside the small line, and at the point where the latter was turned into the horizontal run, the bar was twisted about its own axis through 90 degrees. A hole of sufficient diameter to allow passage of the smaller pipe was burned through this part of the flat bar, after which the pipe was run through it and made up.



The protective bar lends rigidity to the smaller line, and protects it from breakage when struck by a blow originating from a point on a line normal to the axis of the main line. Any force traveling parallel to the main line, while being able to bend the flat bar slightly, nevertheless would tend merely to twist the vertical pipe in one or other fittings near the top of the assembly adjacent to the small valve.

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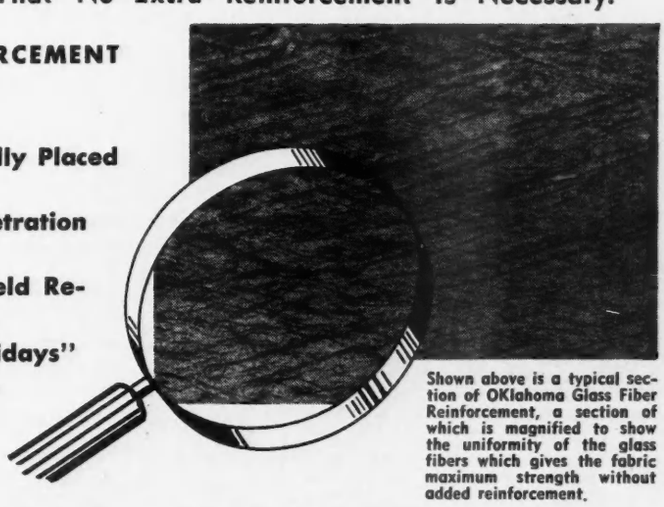

Shown above is a typical section of OKlahoma Glass Fiber Reinforcement, a section of which is magnified to show the uniformity of the glass fibers which gives the fabric maximum strength without added reinforcement.

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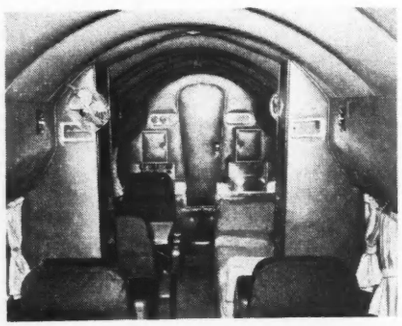

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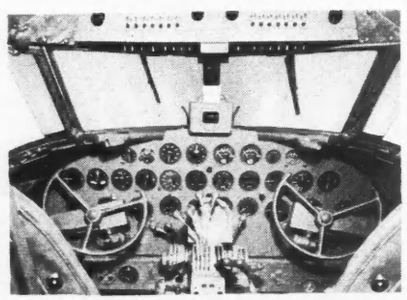

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HOW TO—Build Improved Road Ripper

A common practice among pipe line crews is the use of a truck-pulled road ripping device which reduces much of the labor formerly required in the hand digging of short ditches. One such ripper that has given exceptionally good service has as its principal features an improved ripping tooth and extra-long handle bars, a combination that gives the operator better control. The main tooth, or body of the ripper is a two-foot length of ⅞- x 2-inch steel bar, the lower end being tipped with hard metal, and pointed in such a manner that a maximum digging and lifting effect is obtained. The towing shank is a 20-inch bar of the same material and is securely welded to the ripper bar at a slight angle, and at a point several inches below the middle of the bar. When in the operating position, the ripper then is tilted slightly to the rear. This "angle of attack" of the tooth, together with the use of the extra-long handle bars, gives the operator improved control and stability when extremely hard ground is encountered.

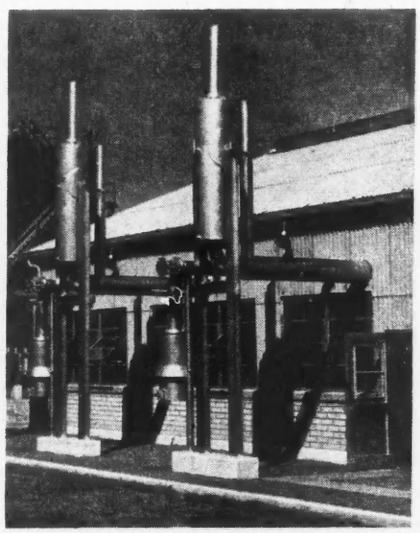
The handle bars, of one-inch pipe, are 30 inches long, but contrary to many such tools used, they are not welded directly to the tooth. Instead, one-inch couplings are welded on at somewhat of an angle, and the threaded ends of the handle bars are screwed in place. The ability to detach the handles when the unit is being carried on the truck facilitates handling and reduces space required to store it.

HOW TO—Remove Exhaust Jacket Heat

During the summer months, heat from overhead exhaust lines can make the engine room of a pipe line station almost unbearable, particularly when these exhaust lines are long and leave the station building from the side rather than the top. To eliminate as much of the heat as possible in such a case, it was found that a jacket around these exhaust lines could be used so the heat was vented.

A light jacket metal completely enclosed the engine exhaust line from the point where it leaves the engine until it enters the muffler located on the outside of the station building. The jacket was closed off around the exhaust where the latter entered the muffler, and a stack welded to the jacket as shown. This riser or stack parallels the muffler and is actually supported by it. Purpose of this stack is to vent the heat into the atmosphere and to cause a draft through the annulus between the exhaust pipe and the jacket, so that heat was removed by convection currents.

During the winter months when it is desired to keep as much heat in the station building as possible, both inlet and vent stack are closed off so that heat generated in the exhaust line radiated throughout the building.



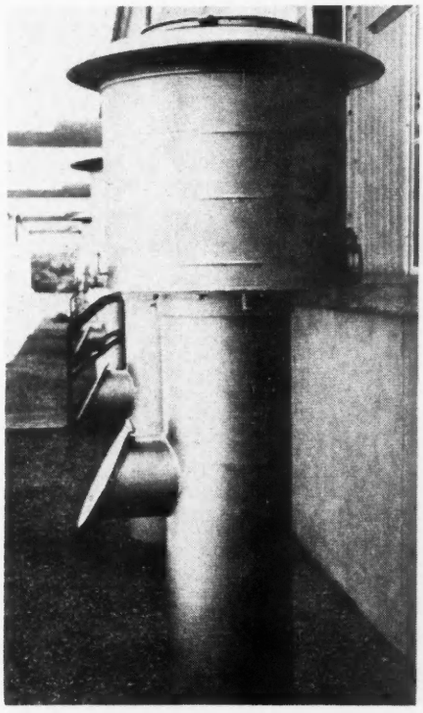
PIPE LINE HINTS

HOW TO—

Vent Air Cleaners

When an air cleaner must be serviced and it is necessary to keep the engine which it serves in operation, the suction through the unit is often so great as to seriously hamper the work.

One pipe line sets a horizontal outlet in the air cleaner riser, and equips the branch with a hinged cover which normally is gasketed and kept closed so as to keep suction through the cleaner. When the cleaner is to be worked on,



however, it is necessary only to open the hinged cover and permit the engine to take suction through the opening thus provided. Since the flow of air through the side opening relieves the cleaner of the suction load, it may then be serviced quickly and by one man.

As soon as it is desired to put the cleaner back in operation, closing of the hinged flap completes the operation.

HOW TO—

Make Flange Jig

A common problem encountered in field welding of pipe lines is the simultaneous aligning and welding of flanges so that a particular flange on one pipe joint will match perfectly the flange on the other joint when the two finally are bolted together. A shop-made jig that greatly simplifies the flange welding job

GRIP-TITE STEARNS— PIPE LINE ANCHOR ASSEMBLY

"The Only Positive Expanding Anchor"

The Grip-Tite Pipe Line Anchor Assembly with Stearns Pipe Saddle was originated and designed especially to meet your demand for positive and permanent hold-downs for all kinds of pipe line construction. They are particularly adapted to marsh and over flow lands as weights for your pipe line.

Grip-Tite Anchors cost only a fraction of cast iron or concrete weights. No heavy equipment is needed for their installation. They save time, labor and other handling expense.

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Grip-Tite earth anchors are described in a feature of this issue.

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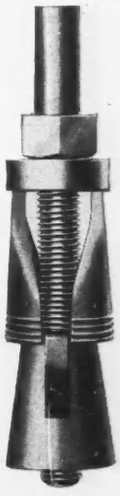
They are made of CERTIFIED MALLEABLE and so constructed that when load is applied, expanding forces anchor wings against the walls of the hole to effect a positive grip at all times. Corrugations on the bearing surfaces of the wings prevent any slippage. The standard 2" size expands to 2⅝" and is equipped with ¾" rod; 3" size expands to 3⅝" and is equipped with 1" or 1¼" rod. Actual tests of 2" size equipped with ¾" rod show a breaking stength of 20,000 lbs.



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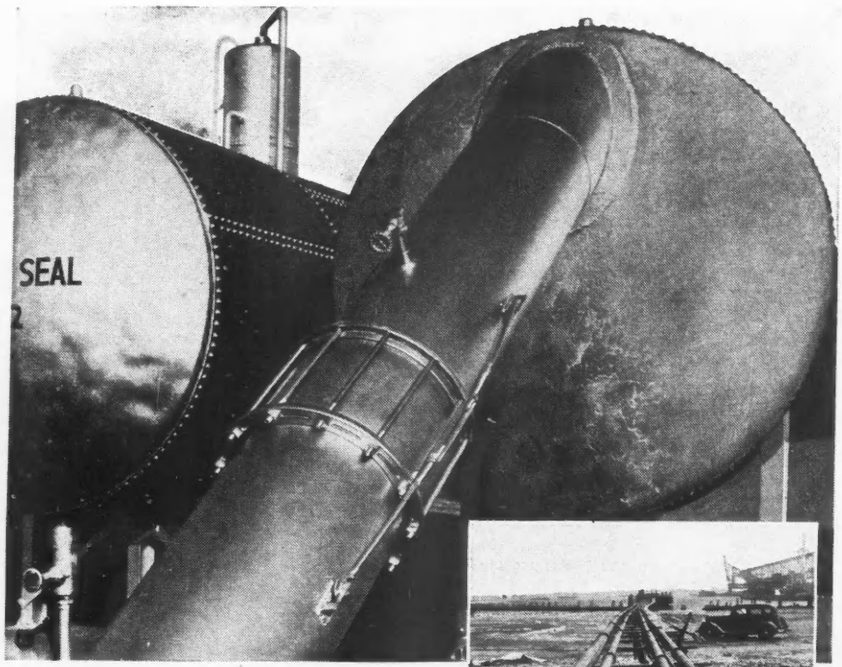
may be made out of a 14-inch length of light pipe, of an inside diameter approximately equal to the outside diameter of the pipe line itself. The short piece of casing is split in half lengthwise, a long hinge attached to one side and a bolt and nut tightening device welded to the other. This arrangement permits the unit to be opened up, positioned on the pipe, then clamped securely to prevent movement during the welding process. Wide, rectangular windows, through which the welder makes his tack welds, are cut in the sides of the jig.

Holding the flange snugly to the end of the pipe is accomplished by the use of two long bolts placed diametrically opposite each other near the front or flange end of the jig. Bolts are attached to ears welded to the side of the jig in such a way that the welder is able to throw back the bolts when necessary. These bolts are run through bolt holes in the flange, and nuts then are tightened down when the welder has aligned and squared the flange face with the pipe axis.

HANDIEST... wherever you have pipe to join



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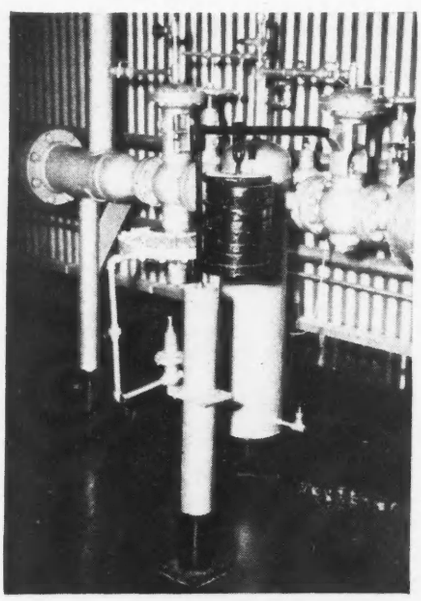
HOW TO—
Control Regulator

To prevent sudden surges through a regulator valve on the fuel line of a compressor station, and also to quiet the swinging and vibration of the heavy weight used to adjust the regulator to pressure conditions, a dashpot was fitted to the outer end of the regulator lever, through a vertical rod with pinned joint at the junction.

The dashpot was formed from a section of two-inch pipe, a section of flat steel welded across the base and drilled to match holes in a support which, in turn, was fastened to the floor. The section above the plate was reamed out to form a smooth inside wall, and a piston, fitting closely inside the cylinder thus formed, attached to the lower end of the



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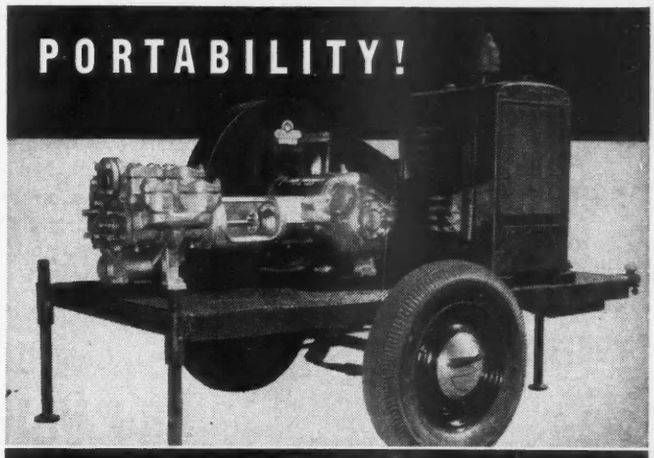

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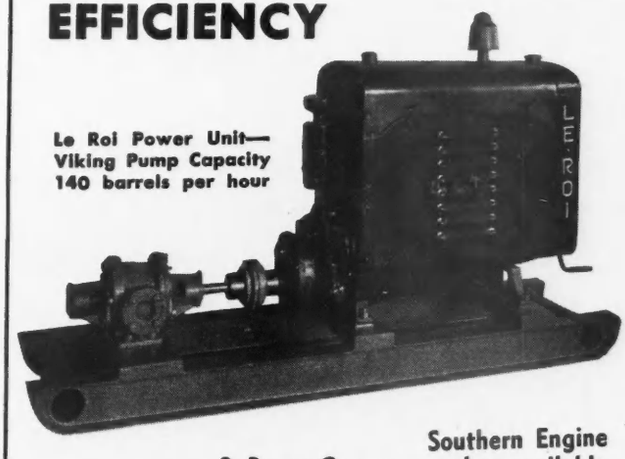

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PIPE LINE HINTS

HOW TO—
Add Valve Bypass

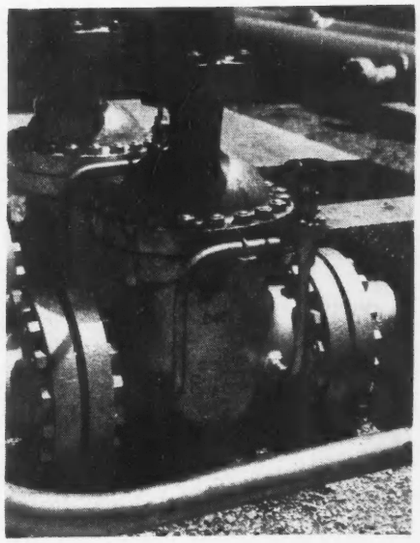
When a gate valve is to be opened against pressure, the job can be considerably lightened if some means be provided for equalizing the pressure against the wedging surfaces, especially in the larger diameter lines.

One pipe line equips the discharge gates with close-coupled bypass units which, welded to the gate body, may remain undisturbed in case one or both of the flanges of the main valve need be adjusted.

The bypass consists of two short lengths of extra-heavy pipe, each welded to a hole in the valve body outside the area of the closing unit. Bent upward to bring the bypass valve within easy operating reach, the two parts of the connecting rod. A small orifice through this piston allowed it to be moved slowly through the oil in the pot, as oil was displaced through the orifice. By varying the size of the orifice, or the viscosity of the oil, the rate of motion could be closely adjusted.

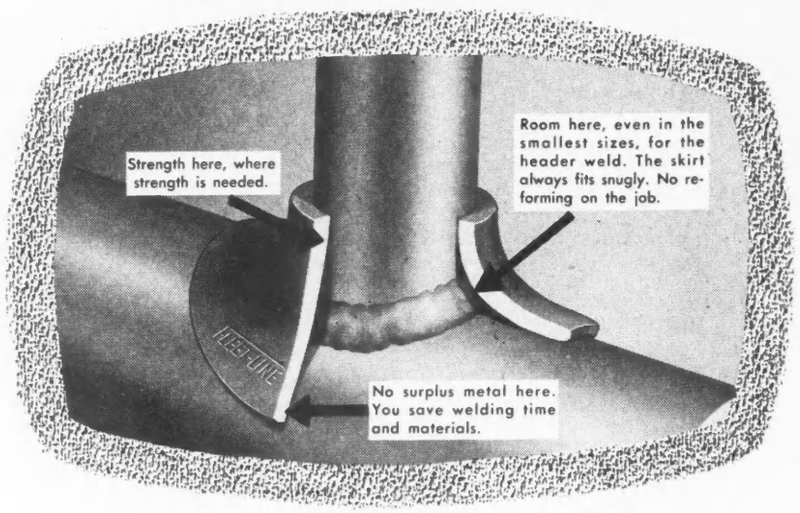
bypass are welded to the body of the angle valve which controls flow through the small line.

A lug of projection, welded to the



body of the valve just below the bonnet flange, supports the bypass line and, with a U-bolt around it, firmly holds it against any attempt to straighten the bends under the effect of line pressure.

BETTER SADDLES
FLEET-LINE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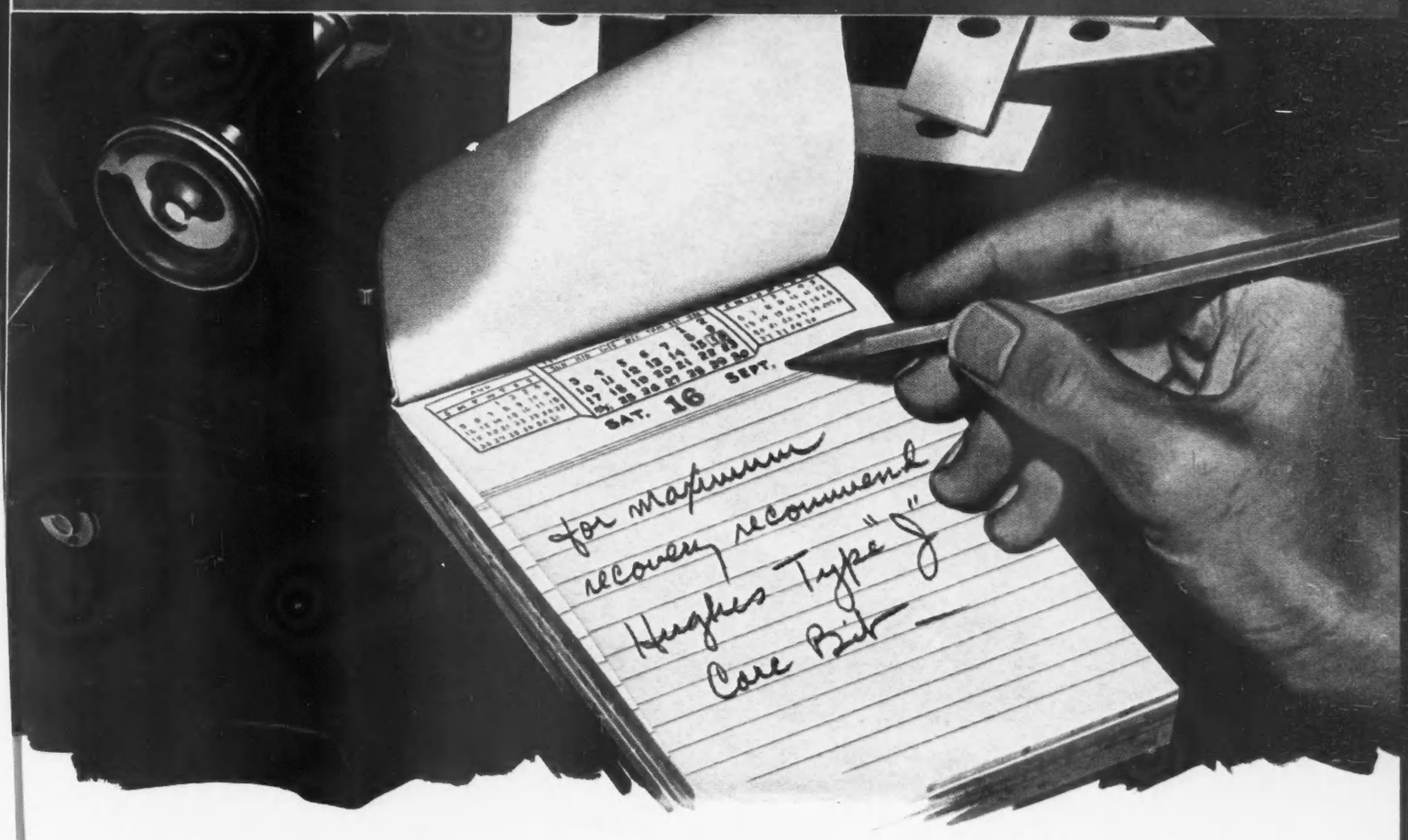

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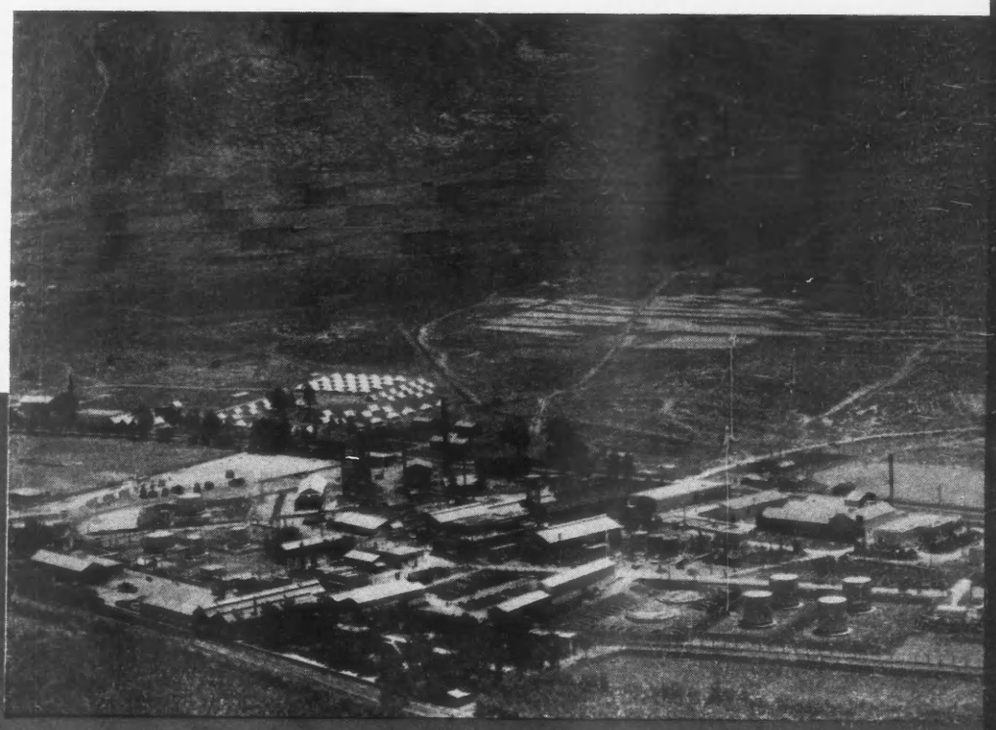


Some of the 93,000-barrel tanks in the Tripoli tank farm, with the 5000-barrel daily refinery in the foreground. Construction work now in progress will double the capacity of the refinery.

Kirkuk Crude Moves Through New Line

CRUDE oil from the Kirkuk field in Iraq started moving to a Mediterranean terminal through Iraq Petroleum Company's new 16-inch pipe line in July, having been delayed for more than a year by the disturbances which resulted in the creation of the State of Israel.

A dual 16-inch system, it was originally designed to carry Iraq oil through the two lines from Kirkuk, one terminating at the Palestinian port of Haifa, and the other following a northern route to a terminus at Tripoli. Construction started on both lines in October, 1946, paralleling existing 12-inch lines from Kirkuk to the company's Station K3 at Haditha on the Euphrates River, each of the new 16-inch carriers having a capacity of 90,000 barrels daily, or twice the capacity of each of the existing 12-inch lines.

The original plan had been first to complete the 620-mile line from Kirkuk to Haifa, and then to proceed with the laying of the northern leg from Kirkuk to Tripoli over a 532-mile route. This plan was followed, good progress being made on the southern leg of the system so that the line was completed to the Palestine border within 50 miles of the Haifa terminal by the spring of 1948, when the disturbed conditions caused the suspension of operations on this line.

Decision was then made to transfer operations, including labor and materials, to the northern leg of the line and complete building the 383-mile sector between K3 Station and Tripoli. This phase of the work was started within a short time after operations halted at the border of Palestine on the southern leg.

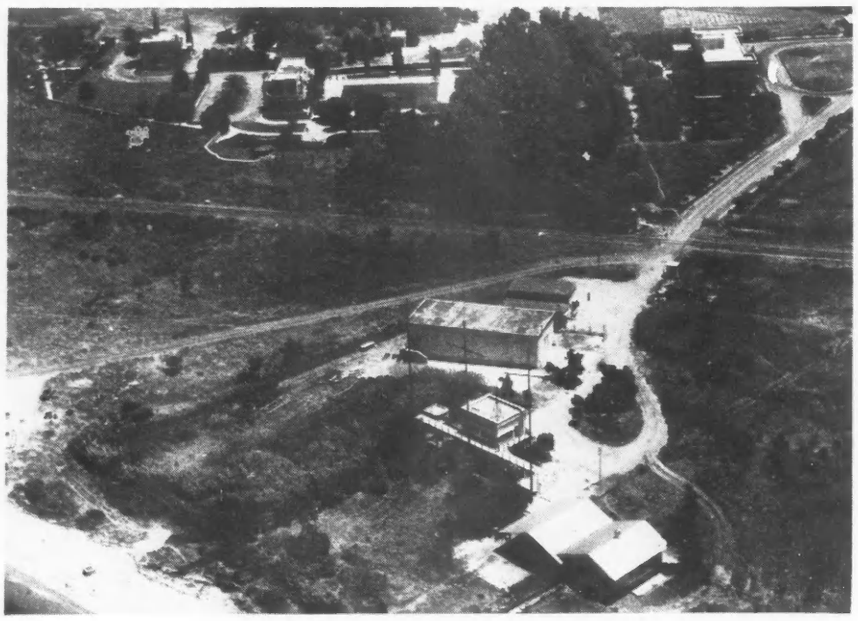
Northern Route

On the northern route just completed, 60,000 tons of 16-inch pipe was laid, involving about 6,287,000 ton-miles of transportation. Stringing of the line was started in May, 1948, and completed a year later. Ditching started in August, 1948, and was completed in June, 1949. The digging of the trench was done on a contract basis, and mechanical ditching machines and excavators were used on about 330 miles of the line in eastern and central Syria, although in the lava and limestone country of western Syria and Lebanon it was necessary to excavate by blasting for an aggregate distance of about 50 miles.

Welding started in October, 1948, and was completed in July, 1949. The welding was done by truck-mounted portable welding units of both British and American manufacture, using rods manufactured in Britain and the U. S. A total of 60,341 welds were made on the line from K3 Station to Tripoli, including 57,383 welds on the main 16-inch line, 640 on the tie-in manifolds, and 2318 at road, rail and river crossings.

Conditioning of the pipe before lowering it into the ditch consisted of the application of one priming coat, followed by a coat of bitumastic enamel, a coating material developed by Iraq Petroleum Company for the particular conditions on the line. A spiral wrapping of glass fiber was then mechanically pulled on so as to sink into the hot coating which had been applied at a temperature of 350 to 400° F. A wrapping of bitumen-impregnated asbestos felt was then pulled on by a second spindle of the same wrapping machine and held by the enamel which penetrated the glass fiber.

Although the complete permanent



The administration building (left) and the Marine Station (right) at the Tripoli Terminal.

pumping equipment for the line has not yet been installed, it was possible to commence pumping through the system from Kirkuk in July by using the completed Kirkuk-K3 section of the line and using standby and temporary pumping units on the new section. It is expected that it will be early in 1950 before the line will be carrying its full rated capacity of 90,000 barrels a day.

Combined Capacity

Ultimately, with both of the new 16-inch lines working along with the existing 12-inch dual line, the combined capacity of the Kirkuk-Mediterranean system will be 270,000 barrels daily. However, under the disturbed conditions following the British surrender of the Palestine Mandate, and more recently the refusal of the Iraq government to allow export of crude oil to Israel, the Kirkuk-Haifa 12-inch line has been shut down since July, 1948. It will not be until it is possible to resolve this latest difficulty so that the 12-inch line may be reopened and the 16-inch southern leg can be completed, that the full capacity of the system will become available.

Attainment of a throughput capacity of 270,000 barrels entails an enlargement of existing pipe line pumping stations and the installation of new stations. The stations between Kirkuk field and the Euphrates point of bifurcation are being re-equipped so that each of the three will have six motor-driven centrifugal pumps, each one capable of handling 156,000 barrels daily at 500 pounds pressure per square inch, to be operated in pairs, in series. Under this arrangement two pairs of pumps will give the desired rated capacity while the third pair will be a standby unit. The pumps are each driven by a separate 1800 horsepower motor with current supplied by its own diesel-driven 1560 KVA alternating current generator, except at K1 station in the Kirkuk field where current will be supplied by the field's power station. The generators are driven by 16-cylinder horizontally opposed diesel engines of British make.

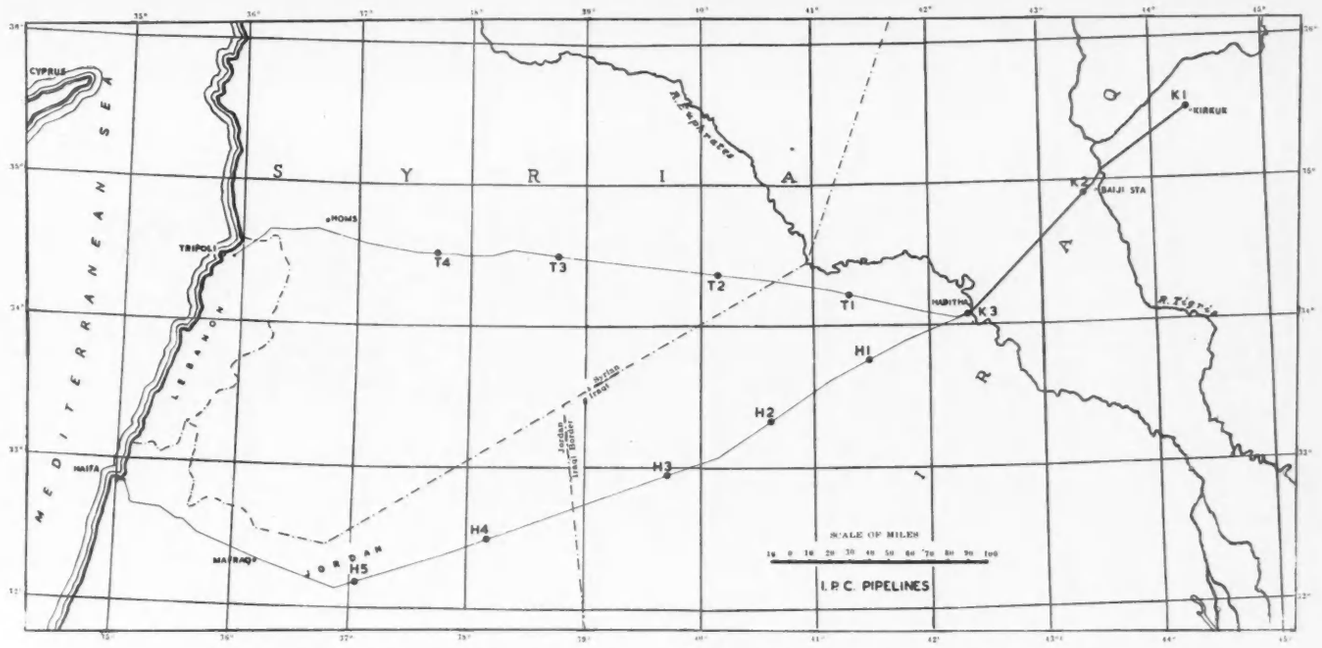
Beyond the point of bifurcation at Haditha, there will be four stations on the north and five stations on the south line. These stations will be uniform, each having the same pumping and power equipment. Reciprocal pumps will be used throughout, four at each station, with capacity of 50,000 barrels daily each, calculated at a line pressure of 1000 psi. The pumps are horizontal units of the triplex, double-acting type with outside-packed opposed pistons of 7¾-inch diameter, with a stroke of 24 inches. The prime movers are airless injection oil engines developing 950 brake horsepower at 300 rpm coupled through a flexible coupling and intermediate shaft passing through the fire wall. They operate on crude oil taken from the line.

Other Construction

In addition to the actual laying of the line and enlargement of the pumping stations, the increase in the capacity of the system has involved a heavy program of construction of other items necessary to the operation of such a project. This includes provision of additional tankage at each pump station and at the Tripoli terminal where the loading capacity is being increased through installation of another marine loading line. Also included is the building of additional housing for supervisory personnel and technical and other workers. With increase in the number of employes at each station it has been necessary also to provide additional capacity for medical and educational needs.

The magnitude of the entire construction program was such that at the peak of construction activity there were

Completing the last weld on the 16-inch line from K3 to Tripoli.



Route of the pipe line which carries crude from the Kirkuk field to the Mediterranean terminal.

11,750 company employes in addition to 3800 employed by contractors.

The original 12-inch system, which started building in the middle of 1932 shortly after it was evident that sufficient reserves existed in Iraq to warrant such a venture, was completed in 1934, the northern leg to Tripoli having been completed in July, and the southern leg in August of that year. They were the first all-welded lines ever built outside the U. S. The stations for the new 16-inch lines are at the sites of the original stations, being an enlarging and re-equipping of the same stations. As originally designed and completed each leg of the line had a capacity of 42,500 barrels daily with the pumping stations using 6¾-inch by 24-inch horizontal double-acting pumps powered by 500-hp diesel engines. There were six units to each station between Kirkuk field and the point of divergence of the two lines, and three units to each of the other stations west of that point.

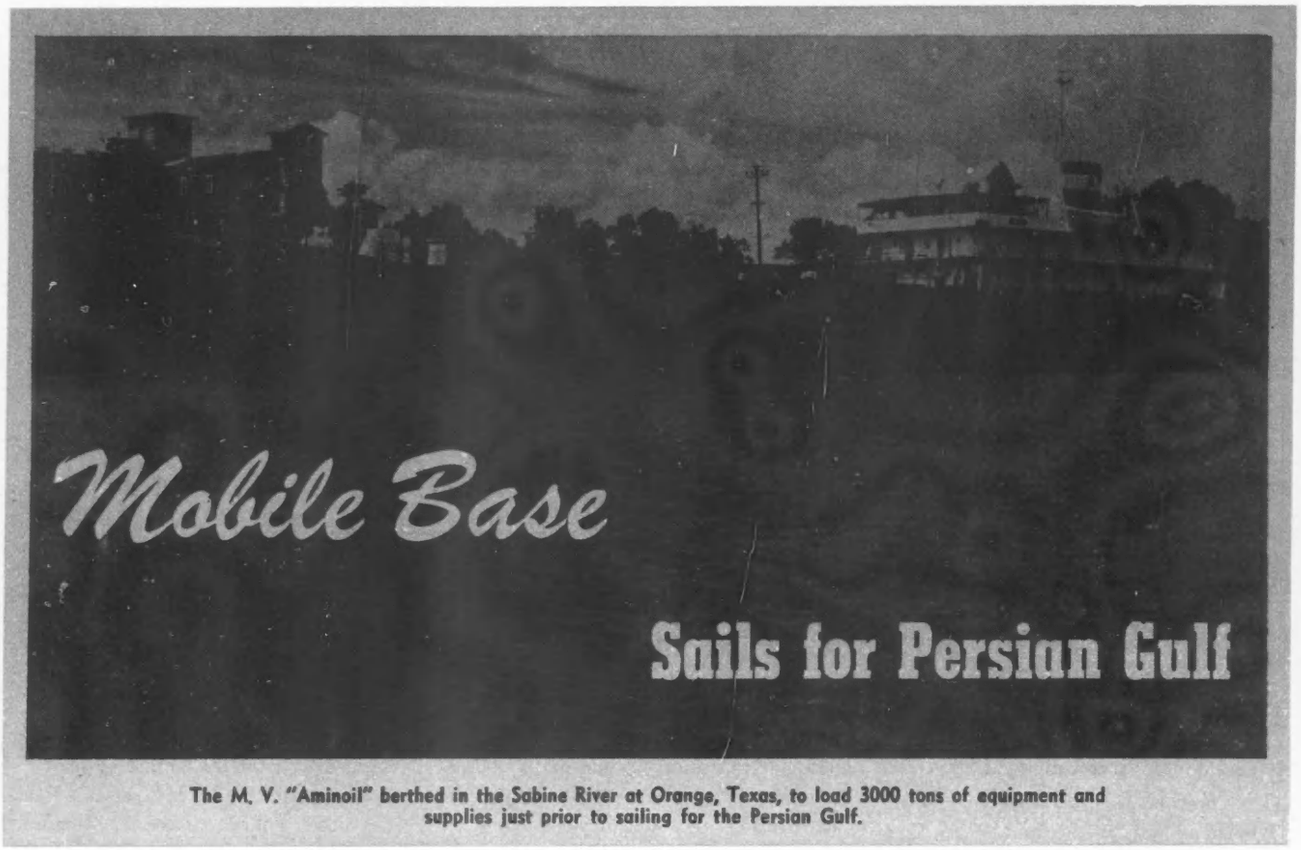
Pumping Stations

The pumping stations supplied, and still supply, the power to sustain the flow of oil through the pipe line and also act as control points for checking quantities transmitted and as bases of operation for line repair and maintenance. Therefore each of these stations amount to miniature towns in artificial oases. Situated in desert country inhabited solely by nomadic tribesmen, every need of the staff must be provided by the company. At each station quarters are provided for senior personnel consisting of houses with four main rooms. Three-room houses are furnished for married engineers, and there is a block of mess kitchens and dining rooms with servants' quarters in addition to blocks of bachelor quarters and accommodations for transients. The housing is constructed to give the greatest possible comfort in a climate where temperatures of 120° F. are common in the summer and where temperature falls far below freezing in the winter.

Also in this region it was advisable to provide a service unit not only to house offices and warehouse stocks, but as a defense post in the event of disturbance. This unit has two-storied bastions at two corners and has provisions for both above and below-ground water storage. It also houses the radio equipment, food stores, ice and cold storage equipment, laundry, bakery, dispensary and hospital rooms.

Oil storage facilities now existing at the terminals and in process of enlargement at Tripoli, consist of 36 93,000-barrel tanks at Tripoli, and 27 93-000-barrel tanks at Haifa. For loading, there are docks for berthing four ships in addition to four 12-inch sea lines for offshore tanker loading. At Tripoli there are three 12-inch sea lines for loading at berths about three-quarters of a mile offshore. Additional loading facilities are now being built at Tripoli.

The crude stabilization plant at Kirkuk, with K1 pump station in the distance.



Mobile Base Sails for Persian Gulf

The M. V. "Aminoil" berthed in the Sabine River at Orange, Texas, to load 3000 tons of equipment and supplies just prior to sailing for the Persian Gulf.

By GEORGE O. IVES
International Editor

THE American Independent Oil Company and Pacific Western Oil Company entered the first phase of actual operations in the Middle East early in October when the M. V. "Aminoil," a converted Navy LST sailed from Orange, Texas, on its seven-week voyage to the Persian Gulf. The 12,500-mile route takes the vessel through the Mediterranean Sea, Suez Canal, Red Sea, around the Arabian Peninsula and up the Persian Gulf to its anchorage off the coast of the Kuwait Neutral Zone between Saudi Arabia and the Sheikhdom of Kuwait.

The concession on the 2500-square mile zone is held jointly by American Independent and J. Paul Getty's Pacific Western company, and under the agreement between the two grantees the former company will handle the initial drilling operations.

Arrival of the "Aminoil" off the northeastern coast of the Neutral Zone will mark the initiation of an entirely new type of operation for the Middle East. The vessel will serve not only as a means of transporting drilling equipment and supplies, but as an integrated base of operations. Moored offshore, it will remain in place as a floating warehouse and at the same time furnish living quarters for all American drilling personnel.

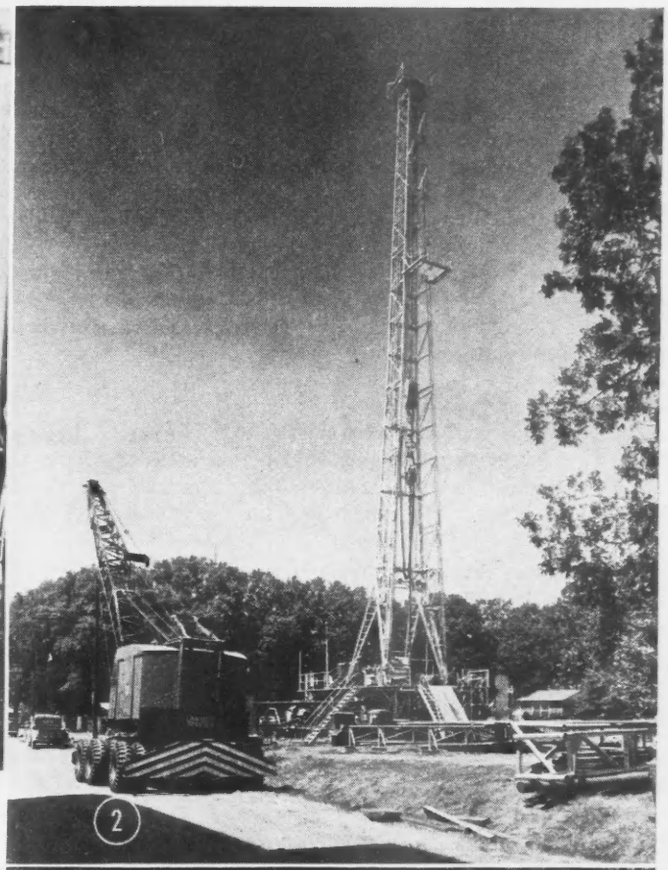
It is anticipated that living conditions aboard the ship will be far more comfortable than would be offered by the type of exploration camp it would be necessary to construct in this barren desert region, and shore installations would be cut down to the construction of combination tent dwellings for what local coolie labor will be employed. A modern house-trailer, with air conditioning, will be spotted at the drill site.

In embarking on this, its first overseas venture at such a distance, the operators have enlisted Kerr-McGee Oil Industries, Inc., and Brown Drilling Company as contractors, charged with the responsibility of assembling drilling machinery and other operational equipment.

The use of a drilling tender in combination with a rigid platform for offshore drilling was pioneered by Kerr-McGee, in the Gulf Coast area of the U. S., using the tender for crew quarters, storage of pipe, drilling mud, etc. For the Kuwait operation, the LST will have no direct connection with the drilling rig, serving only as an operations base, as a home for the crew members, and as a warehouse and machine shop. It will be attended at all times by a marine crew and can be moved from place to place on short notice and under its own 1800 horsepower.

An enormous amount of planning has gone into this project, aside from the actual preliminary exploration of the region where the drilling is to take place. Operators have tried to foresee every need and contingency in connection with an operation 12,500 miles from home and in a region where virtually 100 percent of the basic requirements for subsistence will have to be acquired from other than local sources. As a floating warehouse, the vessel left the U. S. carrying a stock of supplies comprising nearly 40,000 items, including equipment with its spare parts, foodstuffs, medical supplies, etc., sufficient to last for a full year. The machinery carried includes road-building equipment, trucks, personnel transportation equipment, a diesel-powered crane, a 100-foot LCT for use in unloading equipment and a machine shop.

The conversion job, which was done in the shipyards at Orange, was extensive, and included addition of another



1. View of a portion of the recreation room n the "Aminoil," provided as a center of rest and relaxation for personnel.

2. The drilling rig was set up alongside the docks to drill a shallow hole as a test of equipment before loading. The 35-ton crane will be invaluable during loading and unloading operations.

3. The medium duty drawworks to be used in the Kuwait Neutral Zone. The engines have been removed from the skids for ease of loading into the ship's hold.

4. In this view the rig has been disassembled following the short drilling test. In the center is the unitized substructure which has mud, water and air lines permanently installed. A fabricated sub-base has been provided to give an additional two feet of elevation to accommodate another blowout preventer.

deck to the superstructure, building quarters for 75 men who will be accommodated in single and double staterooms. Spacious dining and recreation rooms have been provided and the galley has been enlarged and modernized. Hospital quarters have been enlarged to take care of any eventuality, and laundry facilities will handle the needs of all personnel, including dry cleaning. All of the living quarters have been completely air-conditioned for comfort through the extreme range of temperatures. Radios and record-players are available both in the recreation room and the dining room. The recreation room has been equipped with comfortable furniture for lounging during periods off duty, and the facilities for showing moving pictures include an especially-built projection room.

In the forward part of the hold has been installed a spacious refrigerated compartment for storage of foodstuffs, and a separate deep-freeze room which can accommodate as much as 40 tons of frozen meats in addition to innumerable other frozen food items.

One of the most important installations available on the vessel is the apparatus for making fresh water. Two units of 7500-gallon-a-day capacity will furnish enough fresh water for all needs of the personnel and are expected to furnish requirements for use in drilling. Another standby unit is available for emergency duty.

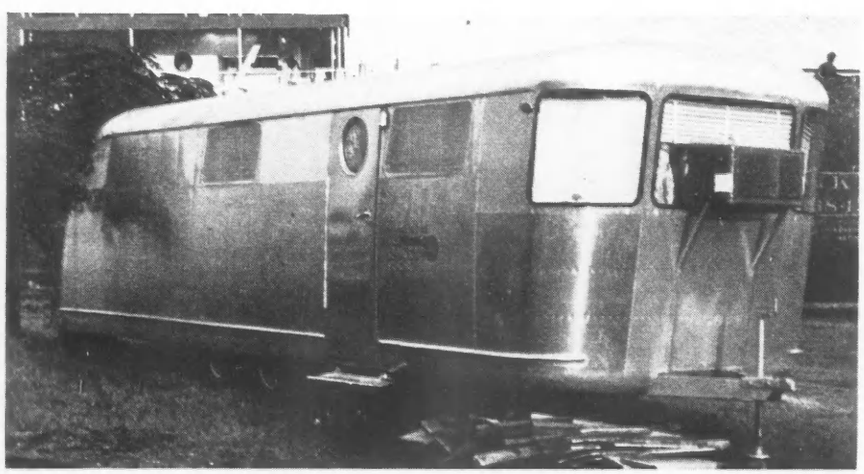
Another convenience of the vessel is the complete permanent installation of radio equipment designed to communicate at great distances, with FM equipment for two-way communication between headquarters on the ship and the rig, trucks and personnel vehicles.

Below-decks provision has been made for warehousing of all stocks of equipment and replacement parts plus enough cement and mud materials for drilling the four wells of the initial phase of the program.

The large tank-deck has been left clear for transportation of the complete rig, including derrick, substructure, drawworks, pumps, tubular goods, steel mud tanks, prefabricated generator house with fuel tanks, etc. When the drilling material has been unloaded, this open space will be available for installation of a machine shop. Two 48-foot hatches will permit entrance of all equipment except the crane, the trucks and the LCT, which are carried as a deck load.

Far-Sighted Planning

Far-sighted planning is evident in the choice of equipment, and the extent of unitization. This includes such items as prefabricated substructure into which has been built manifolds for the mud, water and air systems so that connections need be made only to outlets from the substructure. Electrically driven auxiliary fuel and water pumps are permanently installed and connected into the manifold. Power equipment has been standardized, the operators having settled on a relatively lightweight, high-speed diesel engine as the basic unit, used on the drawworks and pumps as twin-engined units, two such units on the derrick floor and one at the ground-level mud pumps serving as the basic power sources. They are hooked up through conventional compounding units at both the ground and derrick floor levels so that any combination may be used to drive hoisting equipment or pumps. The basic engine units are used wherever possible throughout the equipment, being installed in the two extra-heavy duty trucks, on generating apparatus, 35-ton power crane, ship's tenders, and other equipment with the exception of one crawler tractor. With all parts interchangeable the repair and replacement stocks are kept at a minimum.



The air-conditioned trailer to be positioned at the drill site.

Fortunately for such a remote operation, expected productive formations do not lie at extreme depths in this region, and the actual drilling equipment is not too heavy for convenient handling. A 127-foot portable cantilever-type derrick is being used, and the medium-duty drawworks is capable of drilling to depths in the 6000-6500-foot range with 4½-inch drill pipe, and some additional depth range possible by changing to 3½-inch pipe. Complete strings of both sizes are being carried, along with drill collars, casing, and four complete christmas trees.

Although the drilling rig had already been used to drill one well, it was tested out again after being assembled in Orange for shipment. The complete outfit was rigged up on a vacant lot near the docks and started up, drilling about 40 feet of hole before being taken down for loading.

The drawworks has pneumatic controls with the compressor taking power from the compounding unit, and uses a double 15-inch hydromatic brake mounted atop the drawworks case. The original six-speed transmission has been converted to provide two reverse speeds.

The initial drilling location has been selected about 25 miles inland from the shore of the Persian Gulf at a point very near the northern border of the Neutral Zone, or almost directly south of Kuwait Oil Company's rich Burghan field.

The 2500-square mile area of the Kuwait-Saudi Arabia Neutral Zone is administrated jointly by King Ibn Saud of Saudi Arabia and Sheikh Ahmad of Kuwait. The American Independent Oil Company acquired a concession on Kuwait's undivided half-interest, and Pacific Western Oil Company acquired its undivided half-interest from King Ibn Saud. An agreement has been worked out between the parties for an exploratory campaign to test the zone's oil possibilities, with expenses to be shared by both operators. The ten independent oil operators comprising the American Independent Oil Company are: J. S. Abercrombie, Houston; Ashland Oil and Refining Company, Ashland, Ky.; Ralph K. Davies, San Francisco; Deep Rock Oil Company, Chicago; Globe Oil and Refining Company, Wichita, Kansas; Lario Oil and Gas Company, Wichita; Hancock Oil Company, Long Beach, Calif.; Phillips Petroleum Company, Bartlesville, Okla.; Signal Oil and Gas Company, Los Angeles; and Sunray Oil Company, Tulsa.

With this venture the company goes into operations in two widely separated areas outside the U. S. At the present time it is commencing operations on an exploratory drilling program in the region of the Isthmus of Tehuantepec, Mexico.

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AU-20

New Type Prefabricated House Ideal for Foreign Operations

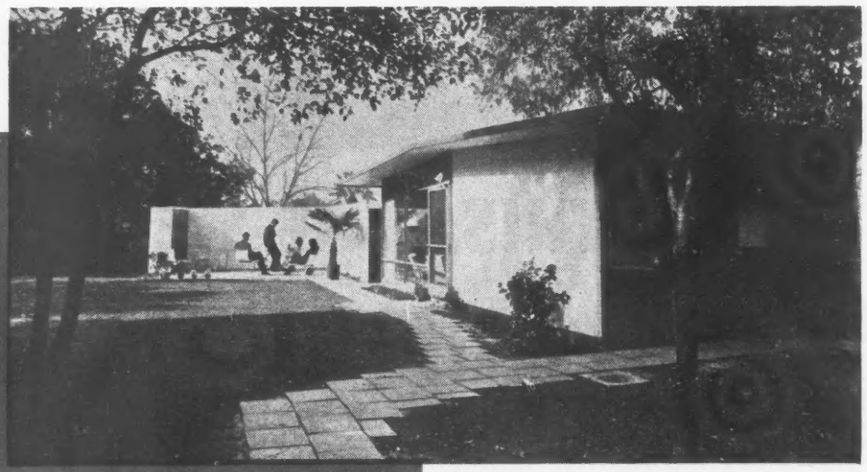

FIGURE 1. Exterior view of completed three-bedroom house. Total time for erection, including pouring of concrete slab, is 400 man-hours. Exterior is given stucco-like appearance when paint is applied at plant before shipping.

By GILBERT M. WILSON
Pacific Coast District Editor

ADEQUATE HOUSING for workers in foreign operations has long been a problem for the industry. The answer may rest in a new, prefabricated unit which offers comfort, unusual portability, and ease of erection.

LIGHT-WEIGHT, prefabricated homes having a degree of comfort and livability equal to those in the U. S., yet so designed that a spacious, three-bedroom house, complete down to the bathroom soap dish, can be shipped abroad in a single packing case measuring 8x10x22 feet, recently has been made available to the oil industry. Easily erected with native labor, even in the most remote areas, the house has numerous features that make it ideal for use in the climate and conditions usually found abroad. Light weight wall and roof panels used have a high degree of resistance to moisture, vermin and fire, and are exceptionally well insulated. The complete house, including pouring of the concrete slab, can be erected complete and ready for occupancy in about 400 man-hours. The completed house, landscaped and occupied, shown in Figure 1, illustrates the pleasing and conventional appearance of a standard three bedroom unit.

It is well recognized that a major problem confronting an oil company moving into a new foreign field, is that of providing adequate employe housing. Morale of the employe, and its consequent effect on the efficiency of his work, depends to a great extent upon the type of housing provided in a remote area. In the construction of a conventional house in foreign fields, the first principal problem is the task of transporting the large quantity of necessary materials to the site, and the second problem is the difficulty of using native labor to assemble and build the dwellings. Both phases of the operation are costly.

Salvageable for Erection Elsewhere

A West Coast contracting firm specializing in oil field construction has developed and made available a pre-fabricated type of dwelling that is ideally suited to the special problems found in foreign fields. It is so constructed that it can be dismantled and moved to another site with but a minimum of cost and time. The ability to salvage all but the concrete slab, and move the complete house to another area is a money-saving feature that lends itself ideally to the often-times temporary camp conditions found at remote wildcat well locations.

Side and roof panels of the house are made of a light-weight, plastic impregnated, honeycomb-like structure bonded between strong sheets of aluminum alloy. Total thickness of the panel material is approximately 1 15/16 inches. Completely sealed and with wiring already installed, the panels are termite- and rodent-proof, and are insulated by the honeycomb structure which contains thousands of tiny dead-air cells. Other desirable qualities which brought about the selection of aluminum for this type of construction are: (1) its resistance to deterioration in tropical climates, lasting indefinitely with little maintenance except for a paint job every few years; (2) its light weight, enabling the construction of large panels that can be erected and dismantled easily; (3) the fact that it is ideally suited for precision cutting and fabrication into panels which, when joined, are virtually dust- and moisture-proof; and (4) its relatively good availability at moderate initial cost.

Considerable engineering skill has gone into the designing of wiring, piping and plumbing so that installation on the job will be an easy task. Each house is completely assembled, wired and plumbed at the plant, then disassembled directly into a specially designed shipping box. Bolts, nuts and loose parts, including spare parts, are shipped in individual, clear, plastic, water-proof containers which also contain lists, visible from outside, of the contents and a description of its use. Material lists and instructions are printed in English as well as the language of the particular country for which destined. Materials in the shipping crate are so arranged that units first needed are on top, and

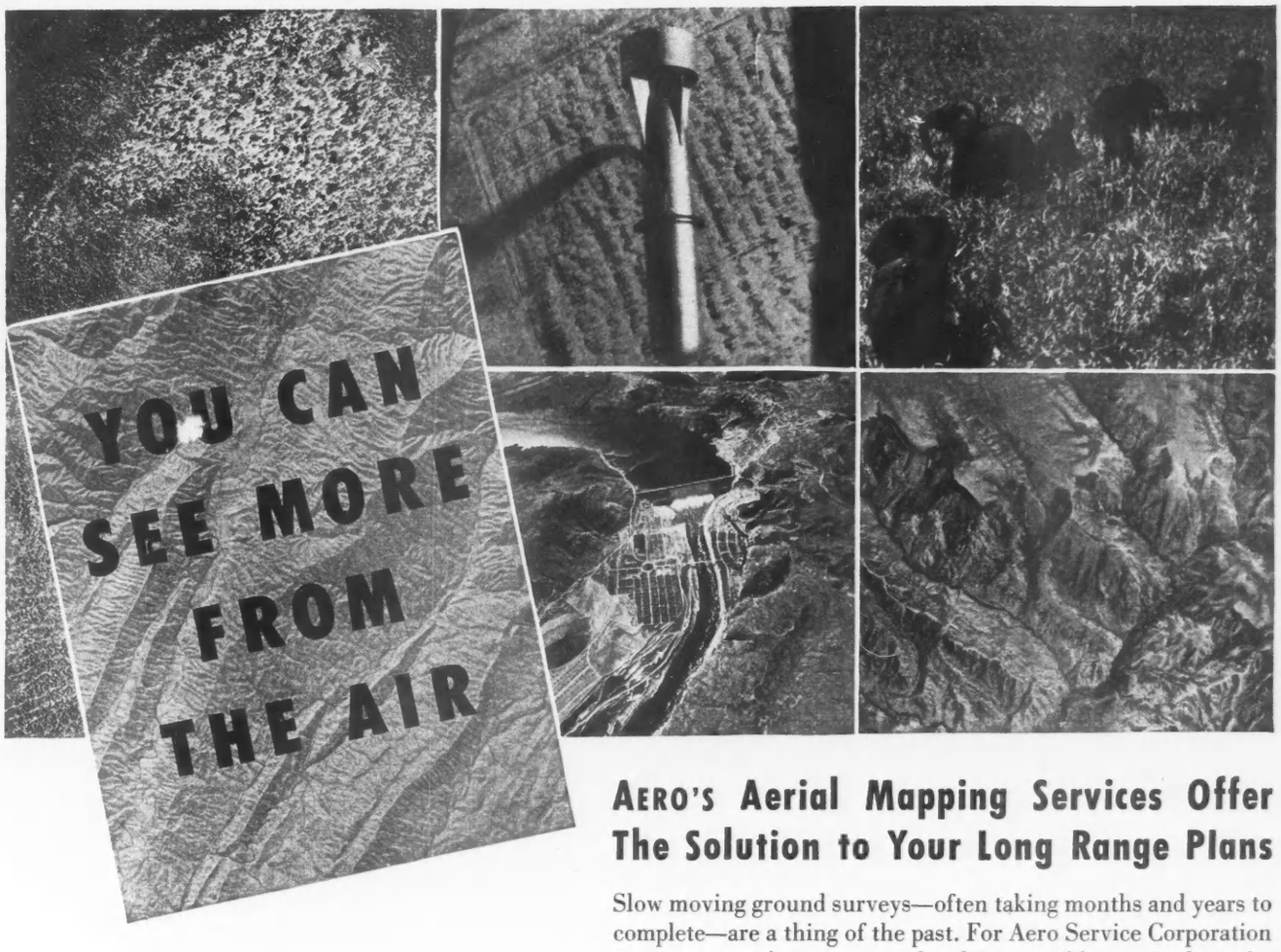

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Figure 2 (top left). The kitchen comes equipped with enameled steel wall and floor cabinets arranged to provide maximum cupboard space. Floors are covered with asphalt tile. All surfaces are painted at factory in choice of colors. Wall panels are equipped with electric wall plug outlets.

Figure 3 (top right). View showing interior of living room, looking toward front door. Furniture has been added to illustrate how the house might be furnished.

Figure 4 (upper middle). View showing manner in which roof panels are raised and placed in position using padded lifting sticks. Panels are factory painted, and are quickly bolted to the wall panels to make a tight, weather-proof joint.

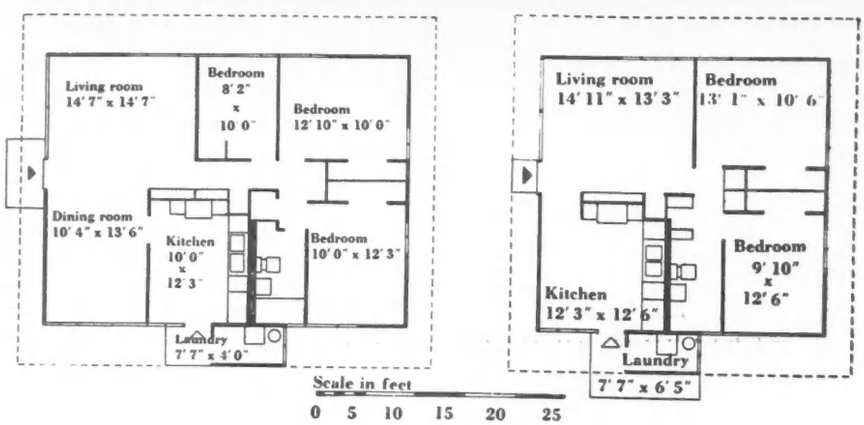
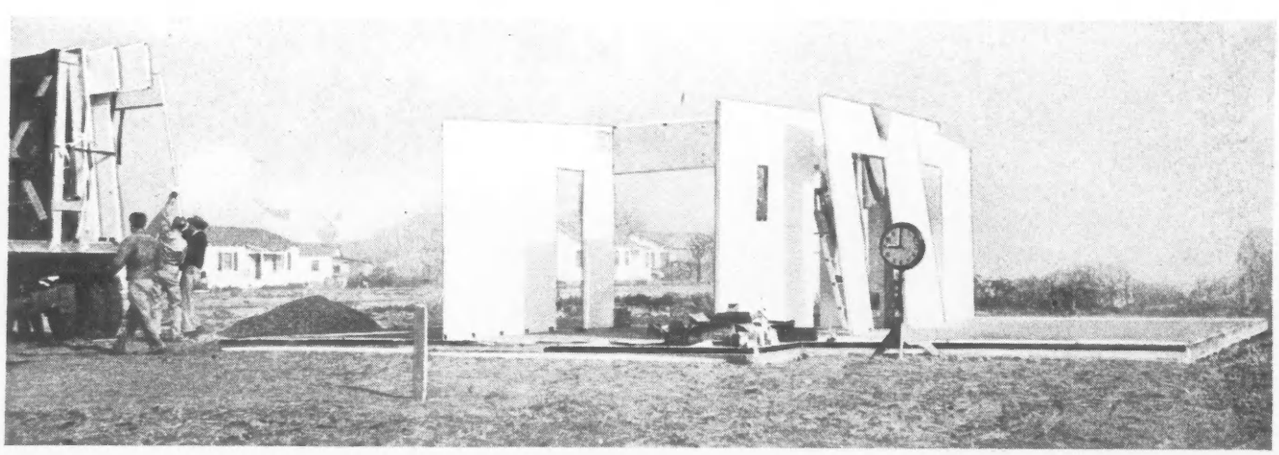
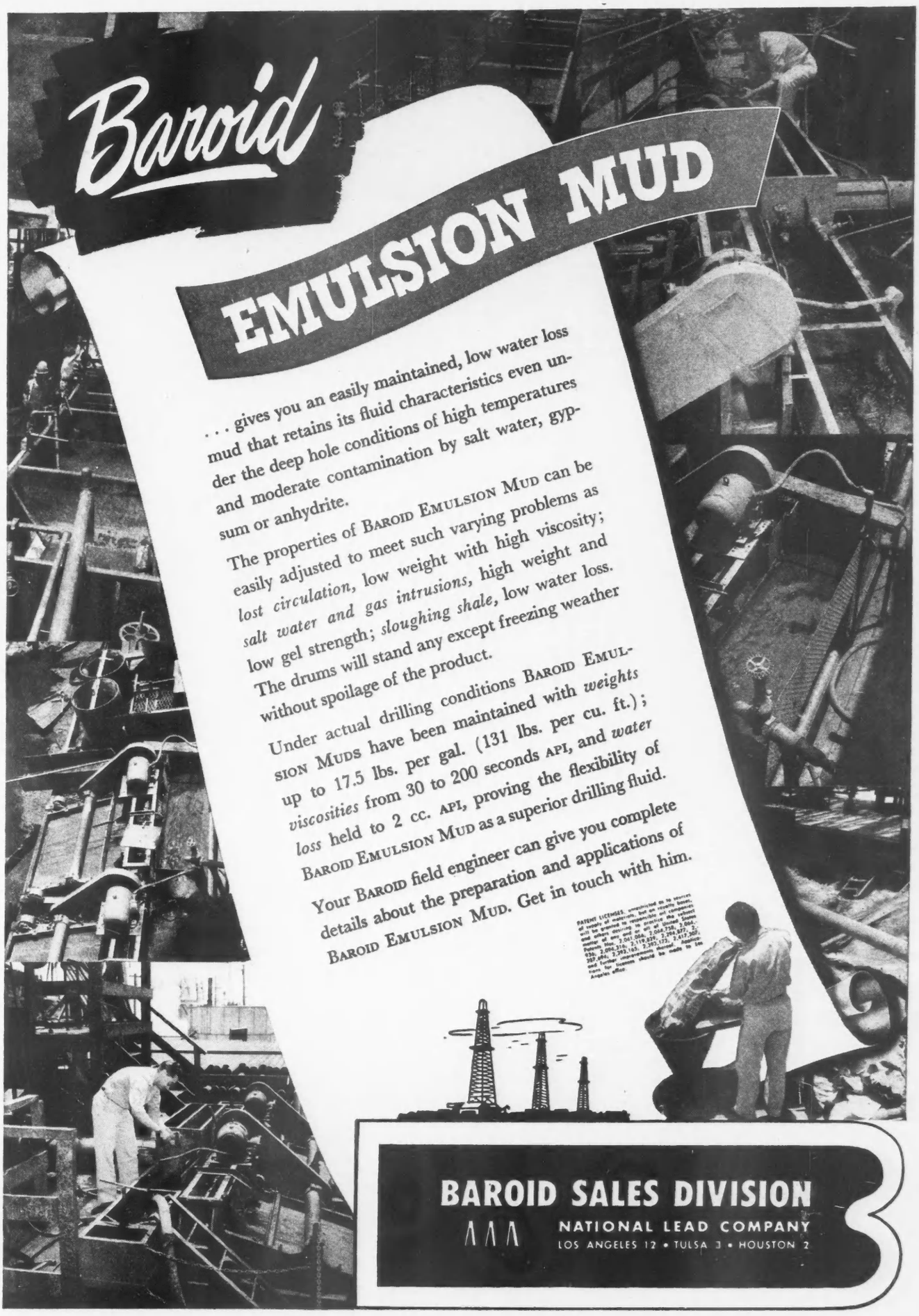


Figure 5 (lower middle). Stock floor plans presently available are the three-bedroom unit (left) and the two bedroom unit (right). Floor areas are 1035 and 810 square feet, respectively. With slight modification units may be converted to field office, recreation building, laboratory or change house. Unitized plumbing grid is installed between kitchen and bath.

Figure 6 (below). Erection of wall panels, shown here while job is under way, can be completed by a six-man crew in nine hours, twenty minutes. Built-in wiring is connected as panels are bolted together.

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It pays to centralize!

...the BAKER way

ONLY through the effective centering of your casing in the open hole can you obtain a sufficiently uniform annular cementing space to permit distribution of the cement slurry completely around the casing. Under this condition the hazard of channeling is minimized and the success of the installation is ensured.

FOR INSTANCE

Even in cementing a fence post in a post hole, you make sure that it is centered before you pour your concrete. You place the concrete all around the post. And you know you are doing a good job because you can see what you are doing throughout the entire operation.

BUT YOU CAN'T SEE DOWN AN OIL WELL!

And since you can't *see* that your casing is properly positioned in the open hole, you can only TRUST to the effectiveness of the centeralizers you have mounted on your casing.

HOW CAN YOU BE SURE?

The point is, how can you have a justifiable confidence that the centralizers you are using are actually *delivering* to the bottom of the hole all of the centering force they appeared to have when you admired them on the rack?

APPEARANCES CAN BE DECEIVING

You don't judge a racing car on the floor of a display room. It may look sleek and powerful there, all right, but that isn't enough to convince you to place your bets on it. No, you judge a racing car during a race–during every lap of the race, but especially during the final, grueling sprint to the finish line.

You can't judge a casing centralizer on the derrick floor. It may look rugged and potentially effective there. But that's not where you center your casing. You judge a centralizer by its ability to deliver effective centering force to the bottom of the hole where its job must be done. At least, that's the way you'd *like* to be able to judge it. The rub is that you can't see what's going on at the bottom of the hole.

BUT THERE IS A WAY TO KNOW . . .

Yes, there is the Baker way – the scientific approach.

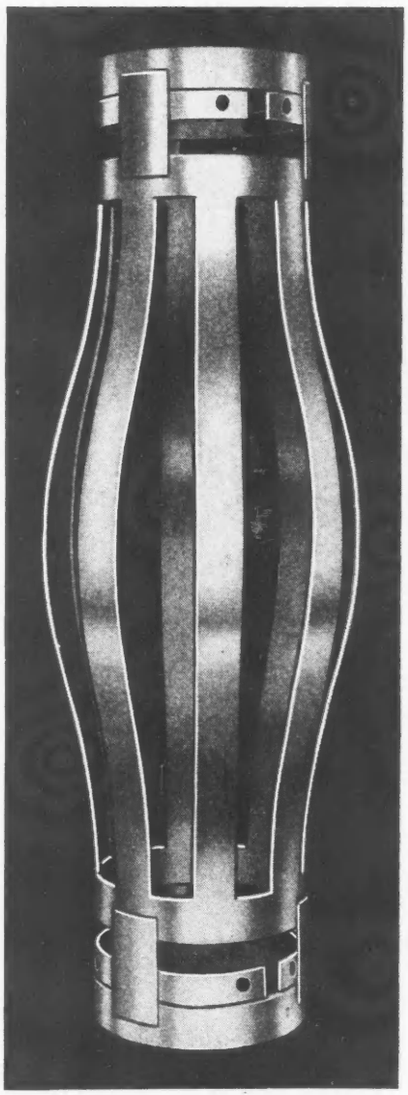
The test of a centralizer is its ability to exert maximum centering force AFTER the repeated flattening of its springs during the trip down-hole.

That's why our testing laboratory here at Baker has been kept in constant use during the design, development, and actual proving of our centralizer. Comprehensive tests, simulating every conceivable hole condition to which a centralizer is subject, were performed by Baker engineers in arriving at the unique design of the Baker Model "G" Casing Centralizer–*The* truly scientifically designed spring-type centralizer. During the course of these tests, every type of spring-type centralizer design was studied. The exclusive Baker Model "G" design proved convincingly to be the optimum.

YOU CAN DEPEND UPON A BAKER CENTRALIZER

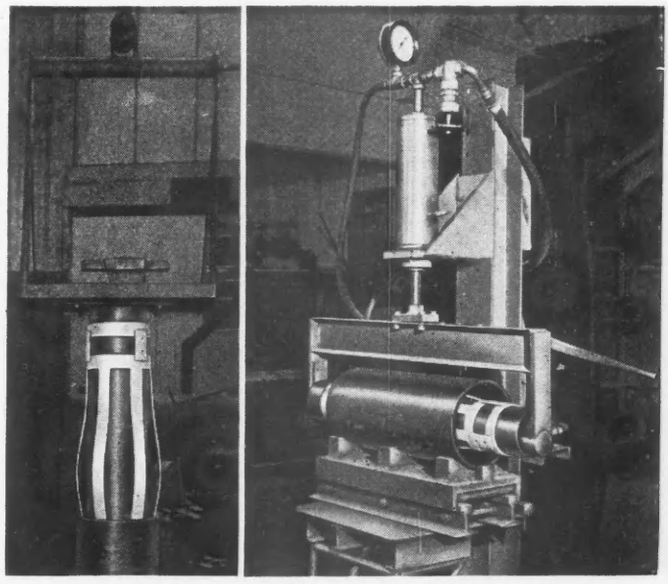
When you run a Baker Model "G" Casing Centralizer you can rest assured that it will do a proper centering job. As an operator, you need no longer worry about trial-and-error centering of your casing, because a Baker centralizer is a proven centralizer. Because of its design, the Baker Model "G" Casing Centralizer offers many exclusive advantages as well as desirable features.

1. It exerts maximum centering force where it is needed–not as the centralizer first enters the well bore or above the first well constriction, but after even the most rugged trip to the bottom of the hole where its actual centering job must be done.



Baker Model "G" Casing Centralizer, Product No. 910-G

2. Its springs are designed on the basis of maximum spring centralizing efficiency alone. The development of its unique mounting design has eliminated the need for sacrificing this ideal spring design to accommodate other factors that complicate previously accepted centralizer designs.
3. Its springs are *never* forced to deflect over the sharp edge of a ring or collar, since they are *butt-welded* (not lap-welded or riveted) to the Spring Collars, and the Stop Rings are positioned safely *outside* of the spring assembly area. Thus the casing supports the total centering force by direct contact with the springs.
4. As its springs deflect, their active length decreases. They are thereby stiffened and their centralizing action is increased.
5. All of its springs are compressed simultaneously as a unit and cannot be deflected individually.
6. Its mounting design permits rotation of the casing even under the most adverse conditions, and within annular clearances smaller than can be approached by any other centralizer.
7. It is, in effect, scientifically "tailor-made" to produce optimum characteristics for each individual casing range.
8. It starts easily and the Baker "tailor-made" feature eliminates the need for snubbing.
9. It is easy to install on the pipe. No on-the-job sizing or adjusting is required. Everything is pre-positioned so that the unit may be merely slipped on the casing and welded in place.
10. It is so designed that it is always PULLED (never pushed) by the casing on which it is mounted. This averts the danger of distorting or otherwise damaging the springs while raising or lowering the casing string past restrictions in the hole.



LEFT: Testing to determine the maximum bowed height and number of springs that can be incorporated into a centralizer and still permit easy starting of the first few joints of casing without "snubbing." RIGHT: With this testing device it is possible not only to simulate rugged down-hole travel by repeatedly flattening the springs, but also to find the effective centering force of the centralizer in the open hole after such treatment. The efficiency of the centralizer can easily be determined from a performance curve showing centering force at various intervals of deflection.

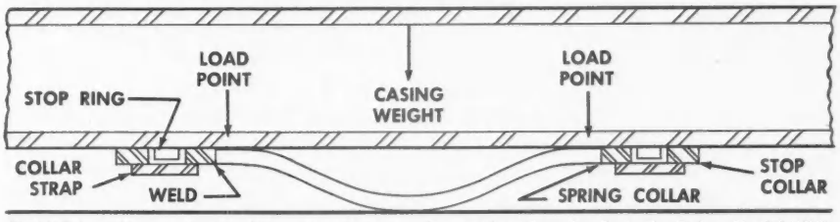


FIGURE 1. — Here is the ideal in spring design and mounting, found only in the Baker Model "G" Casing Centralizer. Note how the load point is imposed directly upon the casing; and how the properly "contoured" spring is free to move along the smooth surface of the casing as it deflects under compression. There is no chance for concentration of stress to cause a permanent set or breaking of the spring. Note that sufficient clearance exists between the Stop Rings and the Centralizer Collars to accommodate the increased length of the Springs that results from their complete flattening.

All of these features contribute to the fact that the Baker Model "G" Casing Centralizer yields greater centering force than any other spring-type casing centralizer within desired annular clearance ranges AT THE BOTTOM OF THE HOLE, where the actual job is to be done.

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so on down through the box, so that a minimum of material or loose parts is exposed to the elements during construction. The contractor supplying the house also has skilled labor to send to supervise construction if desired. Local labor of the country generally does the actual assembly work.

Complete With Plumbing and Wiring

Plumbing and wiring is completed in this country. All plumbing is unitized into a panel between the kitchen and bath. Copper tubing is used throughout, with all outlets and inlets terminating two feet outside the house ready to hook up to facilities at the site. Conventional fixtures such as bathtub, sink, 30-gallon automatic water heater, kitchen fixtures, laundry trays, etc. are included. Enameled steel wall and floor cabinets are featured in the kitchen (Figure 2), which is arranged with ample cupboard space. Very large wardrobe closets also are built into the house. Personal furniture is all that is needed to make a competely livable home.

Each panel is internally wired with three circuits, each designated by a different color. When the panels are erected, like colors of circuits are matched, and the circuits completed with quick-fastening connectors that require no soldering. When the panels are assembled and bolted together, the house is completely wired, ample wall outlets being built into the panels. Fixed, incandescent lighting fixtures are included, although fluorescent fixtures are optional.

The house is erected on a concrete slab which is poured and allowed to set for several days prior to the arrival of the house materials. Anchor bolts for outer walls and partitions may be grouted in when cement is poured, or shot into the concrete with a concrete gun. Panels are fastened to the foundation bolts and to each other, with a simple bolting arrangement that assures accuracy of alignment and tightness. All tools needed for assembly work are included in the shipment. The key inside walls are raised first, after which the outside walls and roof are fastened into position. The plumbing grid is installed after the wall panels are erected. The utilities then are connected, followed by the laying of asphalt tile flooring material. Erection of all wall panels, shown being done in Figure 6, can be completed in slightly over nine hours by a six-man crew. Figure 4 shows the manner in which roof panels are placed, using special padded sticks which facilitate handling. As mentioned before, only 400 man-hours are required to completely erect a three-bedroom house. Generally, a crew of five or six men, supervised by a representative supplied by the contracting firm, is employed to erect the house. A floor template is shipped ahead, or included, as agreed, to eliminate any delay or error in laying of the foundation slab.

Two floor plans, shown in Figure 5, are available. The most popular one is the three-bedroom unit having an area of 1035 square feet. The other plan, with two bedrooms, has an area of 810 square feet. More flexibility in space and room arrangement is possible if units are ordered in sufficient quantities. Plumbing and electrical fixtures may be installed according to the customer's specifications, or, to reduce maintenance stocks at the site, can be ordered to match those already existing on present houses.

Complete House in Single Crate

When the house is erected, it is complete in every detail, down to the front doorbell and mailbox. Each house is zinc chromate primed and completely painted before shipment. Walls take paper or paint, factory-applied in choice of colors. No painting is required once the house is erected. Polished chrome hardware is standard throughout. Windows are factory glazed. Either steel or aluminum sash is available. Flush-type doors are made with honeycomb core, faced with either plywood or aluminum. When completed, the house has the appearance of a modern, wood frame stucco home. Sand sprayed on with the paint gives the appearance of a high grade stucco finish. With slight changes, the house may be adapted to a field office, recreation building, laboratory or change house.

The cellular panels have a "U" Factor of 0.282. This factor, (Btu's per hour per square foot per degree F. that will be transmitted through the walls or roof) is equivalent to that of a wood frame stucco with mineral wool insulation. The wall panel material, a sample of which is shown in cut-away view in Figure 7, is of a type developed during the war in aircraft research. The material stops ordinary sounds, and eliminates the majority of metallic sounds. The house has none of the disadvantages usually thought of in connection with a metal house, it being possible, for example, to drive nails into the walls for hanging pictures.

The three-bedroom house may be shipped in one crate measuring about 8x10-22 feet, but if desired, the package may be broken down into smaller units, this being dependent upon the loading facilities available at the destination. Weight of the house, with crate, is approximately 16,000 pounds. Crating lumber and plywood used are of such quality that they can be used for such purposes as construction forms, small storage structures or for miscellaneous purposes.

Ease of transportation, erection and almost complete salvageability of this new type house will solve many of the problems that occur with setting up operations in not only foreign countries, but remote fields in this country.

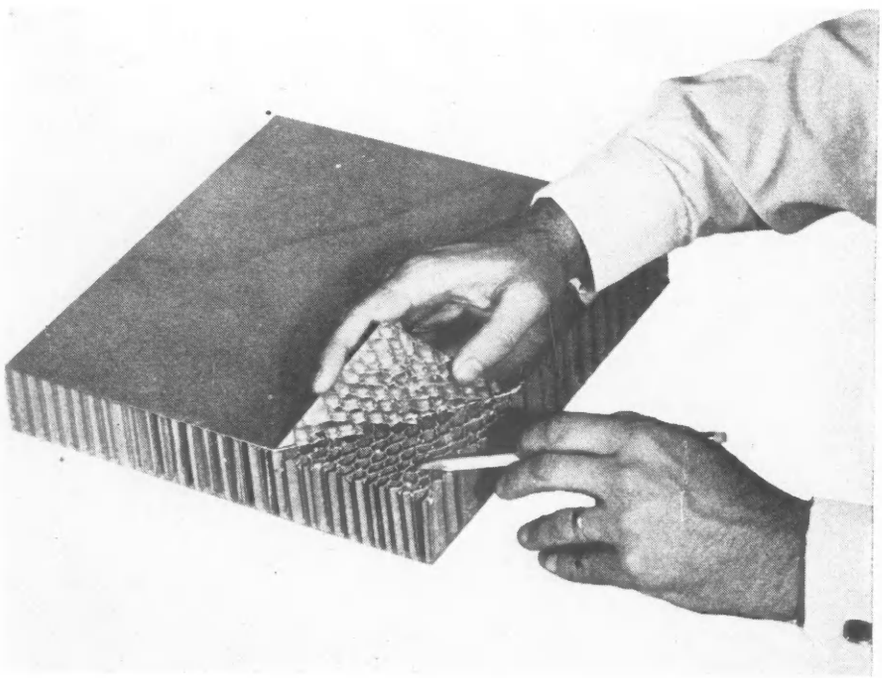

Figure 7. Close-up view of wall panel sample showing how honey comb-like material is bonded between strong sheets of aluminum alloy. Dead air cells provide excellent insulation. Thickness of panel is approximately 1 15/16 inches.

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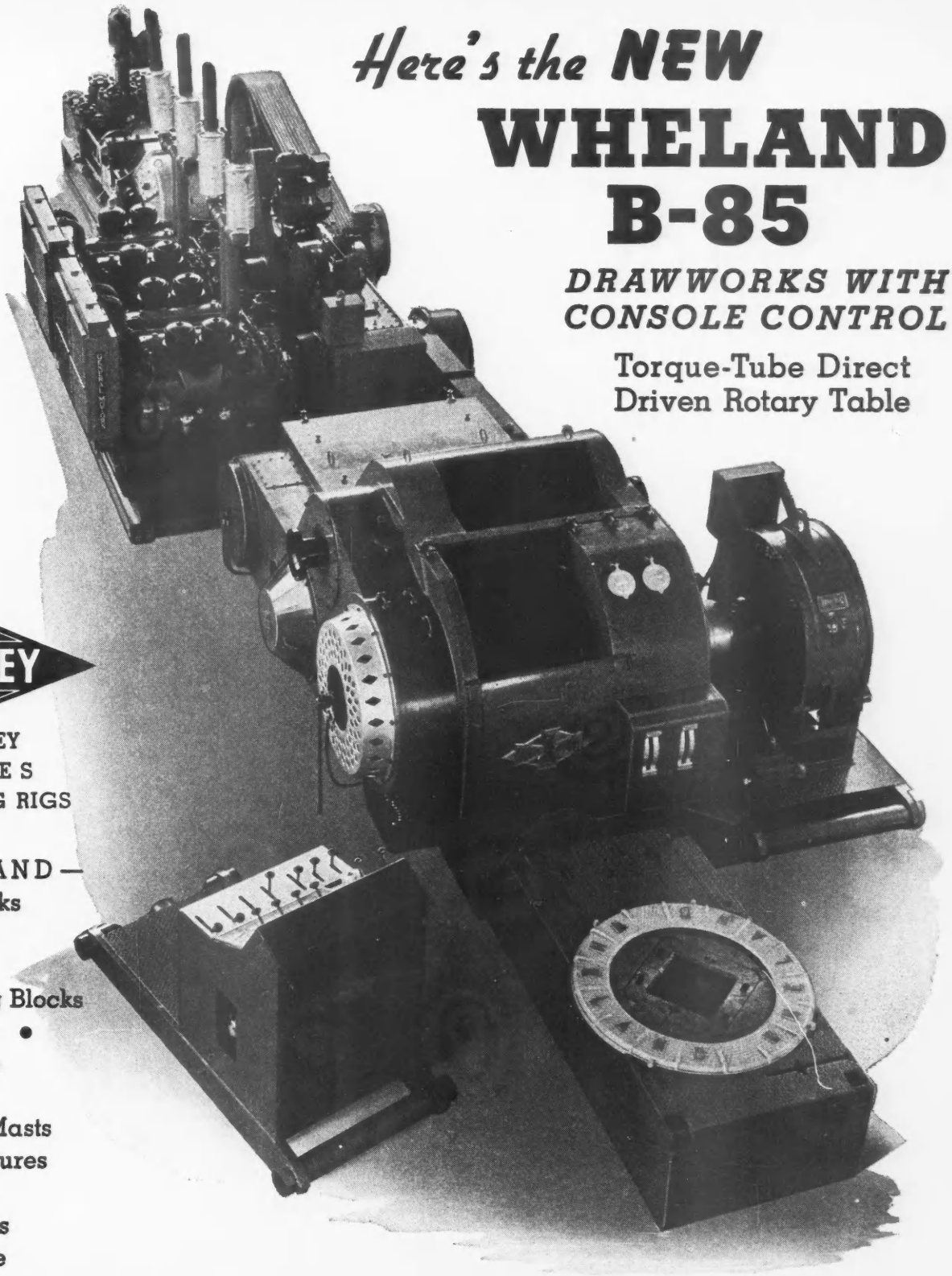

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The State department, with the support of the military and others, is taking the stand that the U. S. should do everything in its power to maintain the American oil position in foreign areas without regard to the British balance of payments. It is that department's contention that America's overseas position is the factor of primary importance. On the other hand, the Treasury department has taken the stand that the primary concern of the U. S. should be to help the British find some means of eliminating the annual drain of $740 million on their dollar pool, currently required for purchases of dollar oil and products and for meeting the dollar costs of their own production.

Backed by other agencies, including ECA, the Treasury depar. ent maintained that this goal should be achieved regardless of the effect on American operations abroad. It argued, moreover, that the government would be under attack from other industries if special consideration be given the oil industry which may not be accorded other industries with foreign interests.

In mid-October it appeared for a short time as though a compromise somewhere between these two viewpoints might have been achieved, but this had fallen down and reconciliation was still to be reached.

The oil talks grew out of the ABC joint economic conference held earlier to investigate the manner in which the sterling area could move toward a position in which it could pay its own way. The questions involving petroleum and shipping represent two of the larger elements in the balance of payment problem. The former is of extreme importance because of the large proportion of dollar cost involved in the production and distribution of oil, and a special conference was decided upon because of the complexity of the problem. At that time, more than a month ago, representatives were delegated to make a study of the facts involved before going into the actual parley stage.

Thus far, although talks have been going on intermittently, nothing concrete had resulted other than an awakening of the public to the gravity of the situation, and a partial realization of its implications toward American foreign operations. There was also a realization of the need for some kind of a national oil policy.

Oil Policy Council

Pointing to the reports of disagreement between two departments which had thus far prevented constructive continuance of the sterling-dollar oil talks, Chairman Harris of the House Commerce Oil Subcommittee said that the need was evident for legislation along the lines of his proposed measure to establish a National Oil Policy Council. The bill would create an oil policy council to develop, clarify, and coordinate national policies relating to petroleum. Harris said his committee was very much interested in the controversies regarding oil policy in connection with the probable effects in the domestic oil industry and Middle East holdings of American firms. He said that "This reported difference of opinion between the two agencies as to the U. S. oil policy is obviously an example of the pressing need for some such legislation."

Other evidence of attention drawn to this problem is the increasing alarm on the part of various industry organizations. Representatives of independent domestic oil producers see the danger that betterment of the sterling oil picture would lead to weakening of dollar oil areas, thus either directly diverting sterling oil to the U. S. or, by indirection, releasing dollar oil now going to sterling areas for imports into the U. S.

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Reported basis of the plan is for the U. S. to be repaid in sterling oil in an amount equivalent to dollar costs assumed by this country, or approximately $200 million worth. It has not been indicated just how the American government is to dispose of this oil.

There is little question that Britain is looking to the ECA to expedite the financing of its vast refinery construction project designed to relieve the British of the drain represented by many current dollar oil purchases. Included in the latest ECA report is an analysis showing that American, British and Dutch companies expect to process by 1953 more than 4 million barrels of crude a day, as against 2.42 million barrels daily in 1948. The entire Marshall Plan area of 16 countries is programming a plant expansion to take care of all the internal needs of the various countries. However, the estimate of this required capacity is believed to be at least 160,000 barrels a day in excess of what actual needs will be, a factor which adds that much more to the petroleum "overage" total for 1953.

The major portion of the funds for this gigantic expansion program is to be furnished by the American taxpayers through whatever grant is authorized by ECA. In its implications it is probably the most crucial single problem that has ever confronted the American petroleum industry.

The latest analysis shows that the British and Dutch plans for a huge expansion of crude production aims at lifting the world output of petroleum to new peaks by 1953, which in the opinion of many industry economists can seriously change, and possibly dislocate, the existing framework of worldwide oil economy. If the program is realized in the currently projected proportions, oil imports into the U. S. might well

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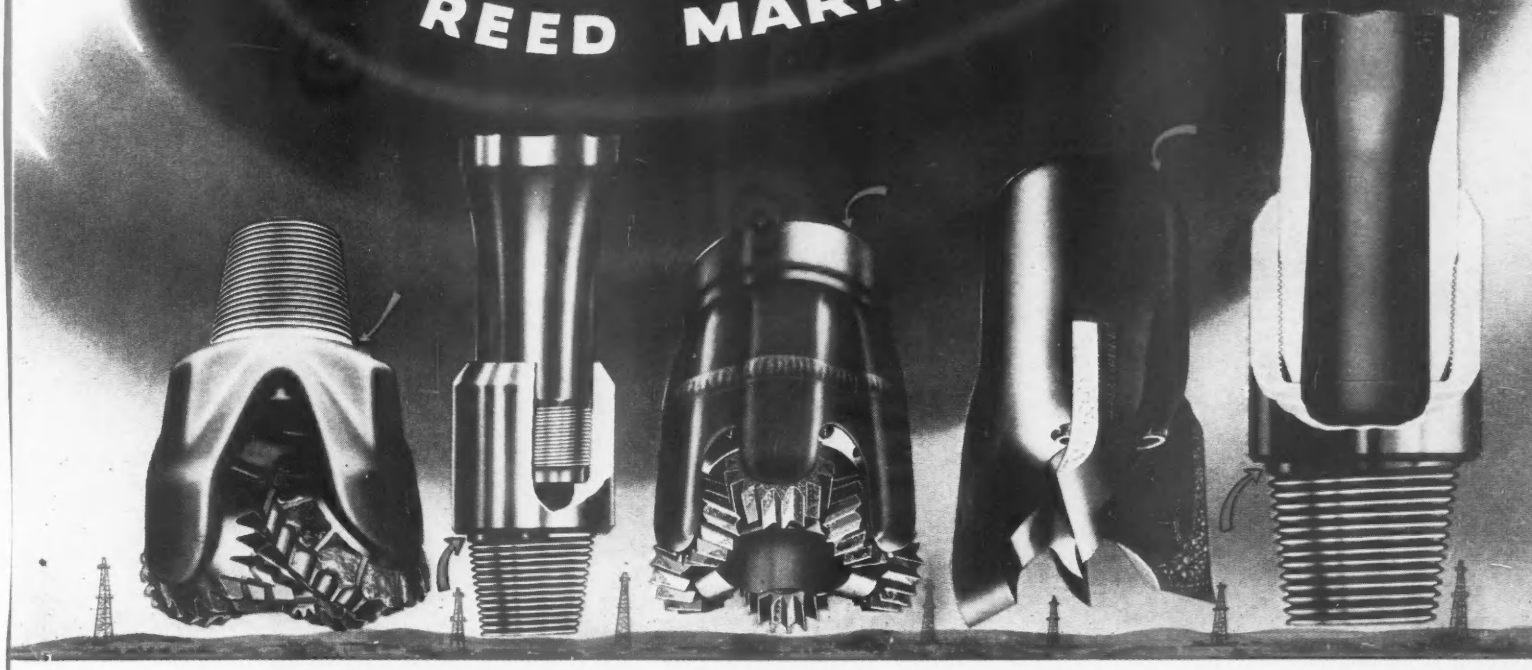

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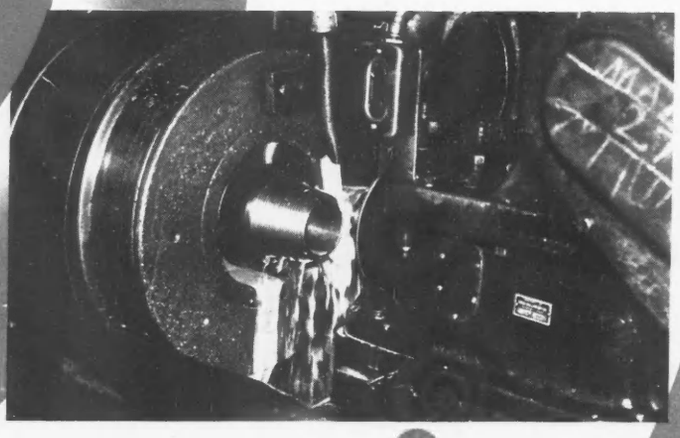

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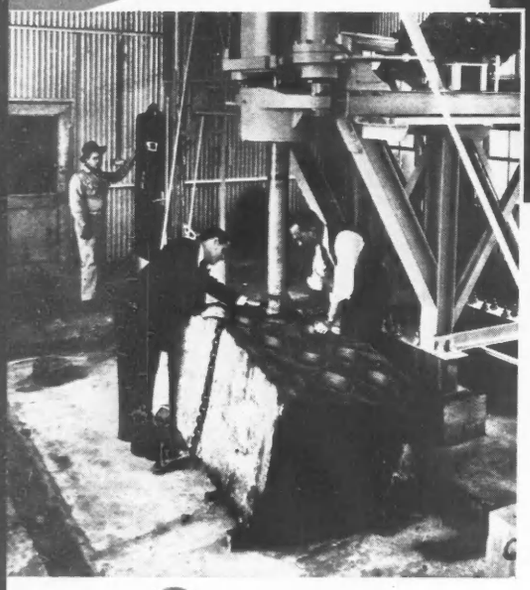

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The program looks toward a Middle East crude production stepup for the five-year period 1948-1953 from about 1.1 million to 2.6 million barrels a day, and for the entire Eastern Hemisphere excluding Soviet areas, from 1.3 million to 3 million barrels daily. For the Western Hemisphere exclusive of North America, a production increase is seen from 1.6 million barrels daily to 1.9 million barrels per day. These figures for the Western Hemisphere break down as follows: American companies to increase from 1 million to 1.15 million barrels a day; British companies from 570,000 barrels to 720,000 barrels daily; and other operators from 56,000 barrels to 82,000 daily.

This Western Hemisphere program will center on the Caribbean area where cost-saving factors are present in the form of currently shutin production and already-constructed pipe lines and loading facilities.

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Over all, the British-Dutch production increase is scheduled at a rate of 15 percent annually over the five-year period, a rate intended not only to supply sufficient crude for their own requirements, but also to leave a surplus which they hope to sell to the Americans. ECA includes a study disclosing where the companies expect to dispose of their increased production. These figures show an "overage" of 936,000 barrels a day of crude and 344,000 barrels a day of refined products by 1953, a combined total of 1.28 million barrels daily. The companies have three ways in which to dispose of this surplus: (1) to stockpile it; (2) to sell it to each other; and (3) to sell it to the U. S. Stockpiling is simply a forced choice in case of tight markets, and selling to each other is no solution for excess supply. It seems certain therefore, that this overage will eventually be seeking entrance into the U. S.

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British Government Declares Oil Will Not Be Nationalized

THE British Labor government has assured Standard Oil Company (N.J.) that it will not nationalize the petroleum industry. This was disclosed by Eugene Holman, Jersey Standard president, in testimony before a joint Senate-House economic subcommittee studying the problems of American investors abroad. Holman said the promise not to nationalize was given his company before it decided to proceed with plans for the expansion in England of the company's refinery at Fawley, a program that at a cost of around $160 million will increase the plant's capacity from 18,000 barrels a day to 110,000 barrels daily.

Since the end of the war, Holman testified, Jersey Standard has spent $500 million in the U. S. and abroad for capital purposes. He said: "The oil industry in the post-war period has been engaged in the greatest capital expenditures program in its history. The magnitude of its undertakings is measured by the fact that from 1945 through 1949, the industry will have spent for additions to property, plant and equipment in the U. S. a total of over $11 billion—equal to about two-thirds of the industry's entire gross investment in this country at the end of 1941.

"In the oil business we must of necessity make large investments abroad. One reason is the nature of our supplies. Oil deposits have been placed by Nature in many sections of the globe, often far from the main centers of use. We have to invest money to find and produce from these scattered areas.

"For example, as a result of rising European demand and the development of Middle East sources of crude, our affiliates are building increased refining capacity in Europe. Expanding U. S. refineries to supply these markets would be inefficient. It would mean bringing crude from Eastern Hemisphere sources, refining it, and shipping the products back to customers in Europe, Africa or Asia."

Exchange controls, Holman said, are strangling international trade. "Not only is the well-being of a particular country lowered by today's operations of exchange controls, but the effects spread out to the rest of the world. Western European customers, for example, cannot import today as much petroleum as they would like because they cannot pay for it. Their countries have set up import restrictions and exchange controls.

"Exchange controls are not used in all cases simply as an aid to the rationing of petroleum or the conservation of dollars. In certain cases the operation of exchange control places American companies at a disadvantage compared with foreign companies. For example, American companies are unable to sell oil for sterling today. Some countries though unable or unwilling to pay dollars for petroleum, would be able and willing to pay American companies in sterling. We on our side would be willing to accept sterling payment provided we were able to put these funds to use. We do not believe that permitting us to operate in sterling would occasion any important dollar drain on the United Kingdom."

Holman cited government monopoly as another undesirable form of trade restriction. "Some of the nations of Latin America furnish illustrations. For example, the government may forbid private business concerns to explore for, or produce, petroleum in the country. The country's economic problems probably cannot be solved without the liquid energy provided by oil. Yet the absence of an atmosphere healthy to free investment prevents development of its oil resources."

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On September 28 the ECA released a statement announcing a grant of $21,420,500 for increasing the refinery capacity of several companies in England and France. Of this amount, $2,277,500 was allocated to American companies who have installations there, while the remaining $19,193,000 is to be used by British-Dutch companies.

British Government Declares Oil Will Not Be Nationalized

THE British Labor government has assured Standard Oil Company (N.J.) that it will not nationalize the petroleum industry. This was disclosed by Eugene Holman, Jersey Standard president, in testimony before a joint Senate-House economic subcommittee studying the problems of American investors abroad. Holman said the promise not to nationalize was given his company before it decided to proceed with plans for the expansion in England of the company's refinery at Fawley, a program that at a cost of around $160 million will increase the plant's capacity from 18,000 barrels a day to 110,000 barrels daily.

Since the end of the war, Holman testified, Jersey Standard has spent $500 million in the U. S. and abroad for capital purposes. He said: "The oil industry in the post-war period has been engaged in the greatest capital expenditures program in its history. The magnitude of its undertakings is measured by the fact that from 1945 through 1949, the industry will have spent for additions to property, plant and equipment in the U. S. a total of over $11 billion—equal to about two-thirds of the industry's entire gross investment in this country at the end of 1941.

"In the oil business we must of necessity make large investments abroad. One reason is the nature of our supplies. Oil deposits have been placed by Nature in many sections of the globe, often far from the main centers of use. We have to invest money to find and produce from these scattered areas.

"For example, as a result of rising European demand and the development of Middle East sources of crude, our affiliates are building increased refining capacity in Europe. Expanding U. S. refineries to supply these markets would be inefficient. It would mean bringing crude from Eastern Hemisphere sources, refining it, and shipping the products back to customers in Europe, Africa or Asia."

Exchange controls, Holman said, are strangling international trade. "Not only is the well-being of a particular country lowered by today's operations of exchange controls, but the effects spread out to the rest of the world. Western European customers, for example, cannot import today as much petroleum as they would like because they cannot pay for it. Their countries have set up import restrictions and exchange controls.

"Exchange controls are not used in all cases simply as an aid to the rationing of petroleum or the conservation of dollars. In certain cases the operation of exchange control places American companies at a disadvantage compared with foreign companies. For example, American companies are unable to sell oil for sterling today. Some countries though unable or unwilling to pay dollars for petroleum, would be able and willing to pay American companies in sterling. We on our side would be willing to accept sterling payment provided we were able to put these funds to use. We do not believe that permitting us to operate in sterling would occasion any important dollar drain on the United Kingdom."

Holman cited government monopoly as another undesirable form of trade restriction. "Some of the nations of Latin America furnish illustrations. For example, the government may forbid private business concerns to explore for, or produce, petroleum in the country. The country's economic problems probably cannot be solved without the liquid energy provided by oil. Yet the absence of an atmosphere healthy to free investment prevents development of its oil resources."

Alberta *Production* Up— *Allowables* Down

CANADIAN oil producers found several reasons for optimism as they reviewed their situation recently and realized they had survived devaluation without appreciable harm. In line with the increased cost of imported oils, the posted prices of Alberta crudes were advanced 25 cents per barrel by Imperial Oil, Ltd., as applied to the Leduc, Calmar, and Woodbend areas, while Turner Valley and Redwater prices were raised 20 cents per barrel. Adjusted prices are as follows:

Leduc, Calmar, Woodbend	$3.20
Redwater	2.88
Golden Spike	3.18
Turner Valley (Avg. 43°)	3.64

(Turner Valley's light oils are purchased on a gravity basis, with $3.44 now being paid for 33/33.9 gravity, increasing two cents for each degree of gravity, making oil of 64° and above worth $4.06 per barrel.)

October Revision

These adjustments served partially to soften the blow felt in the October downward revision in pro rata acceptances by pipe line companies, which were not unexpected in view of the rapid increase in the number of producing wells, now exceeding 1000 in the province as a whole, each of which is entitled to a pro rata share in the available market demand, now limited by tank car freight rates. This reduction in pipe line purchases, which approximated 25 percent in the active areas, came at the end of the harvest and tourist seasons, and at a time when new maximum production records were being announced every week, as reports were tabulated by the Petroleum and Natural Gas Conservation Board. Late reports indicate that daily average production by principal fields is approximately as in Table 1, representing an over-all increase of more than 100 percent during the past twelve months.

Canadian operators are now settling down to await completion, 18 months from now, of the Interprovincial Pipe Line, which is planned to be finished in time for the opening of navigation on the Great Lakes waterways in the spring of 1951. This line is expected to extend the marketing radius for Canadian oils to all Canadian refineries, and perhaps also to U. S. plants situated along the shores of the Great Lakes.

Table 1

Field	(Barrels) Daily Average Crude Oil Production	Operating Oil Wells
Leduc, Calmar, Woodbend	30,584	323
Redwater	24,706	187
Turner Valley, Crude Oil	10,479	300
Turner Valley, Gasoline	1,044	
Lloydminster, estimated	1,940	83
Other fields, estimated	1,590	97
Totals	70,343	990

Alberta oil producers also had a psychological lift with announcement of the first shipment of Canadian oil products to be exported to the U. S., symbolically reversing the flow of oil between the two countries. This historic shipment was represented by 3060 gallons of diesel fuel, refined in Moose Jaw, Saskatchewan, from Lloydminster crude oil. It was moved by truck transport, consigned to the Montana-Dakota Utilities Company at Scobey, Mont. An import tax of one-fourth cent per gallon was assessed by U. S. customs authorities.

Inter-party debate in the Canadian Parliament at Ottawa also brought forth a statement of Dominion policy with respect to exporting Canadian oils to American consumers. A few minority groups have objected to the selection of an international route instead of a longer and more costly route across Canadian soil for the new pipe line to Great Lakes refineries. In this connection, criticism was offered of the proposal to export Canadian oils on a regional basis while both the Pacific and Atlantic coasts of Canada are still dependent on imported petroleum and its products. A spokesman representing the Federal Cabinet stated unequivocally that it is the policy of the Canadian government to sponsor such an interchange between the U. S. and Canada, so as to gain in the Middle West U. S. exchange with which to pay for other oils imported into eastern Canada and into the trans-mountain regions of the Pacific Coast. Critics of this policy were reminded that during two world wars the American people had supplied scarce petroleum and petroleum products to Canada. Right Hon. C. D. Howe, minister of Trade and Commerce, asserted that this is no time to adopt "a little Canadian" attitude. Continuing, he applied the same reasoning to iron ore, remarking that Canada's steel industry has long been dependent on American ore, but that he is in no way horrified by the thought that the U. S. steel industry in future may draw supplies from Canadian sources.

Another cause for optimism was found in an announcement by Hon. N. E. Tanner, minister of Mines and Minerals, of the formation of a special advisory board, under the chairmanship of Dean W. G. Hardy of the engineering school of the University of Alberta, which is empowered to recommend extensions of time under Crown reservations, prospecting licenses, and oil and gas leases granted by the Alberta government. Other members include H. G. Jensen, of the Eastern Rockies Conservation Board, N. A. Macleod, solicitor to the Mines department, and G. H. N. Monkman, deputy minister of Public Works. It is known that many of the oil companies holding acreage in Alberta have reserved more acreage than they could explore within the time limits set for the performance of work assumed in the acquisition of oil rights, and this prospect of relief is welcomed as a factor which will ameliorate conditions during the long wait for the widening of the radius within which Alberta oils can be marketed. Thus, the extension of time to perform drilling obligations may tend to stabilize market conditions by flattening out the drilling boom.

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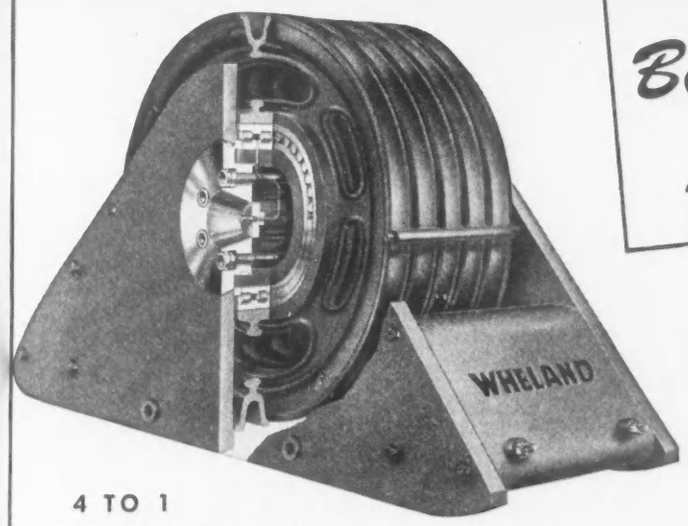

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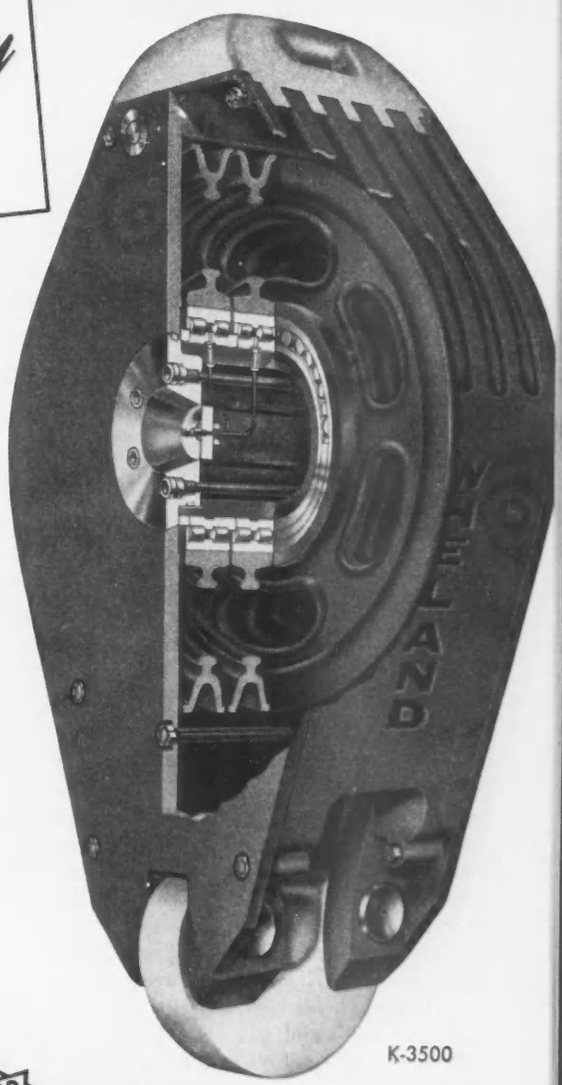

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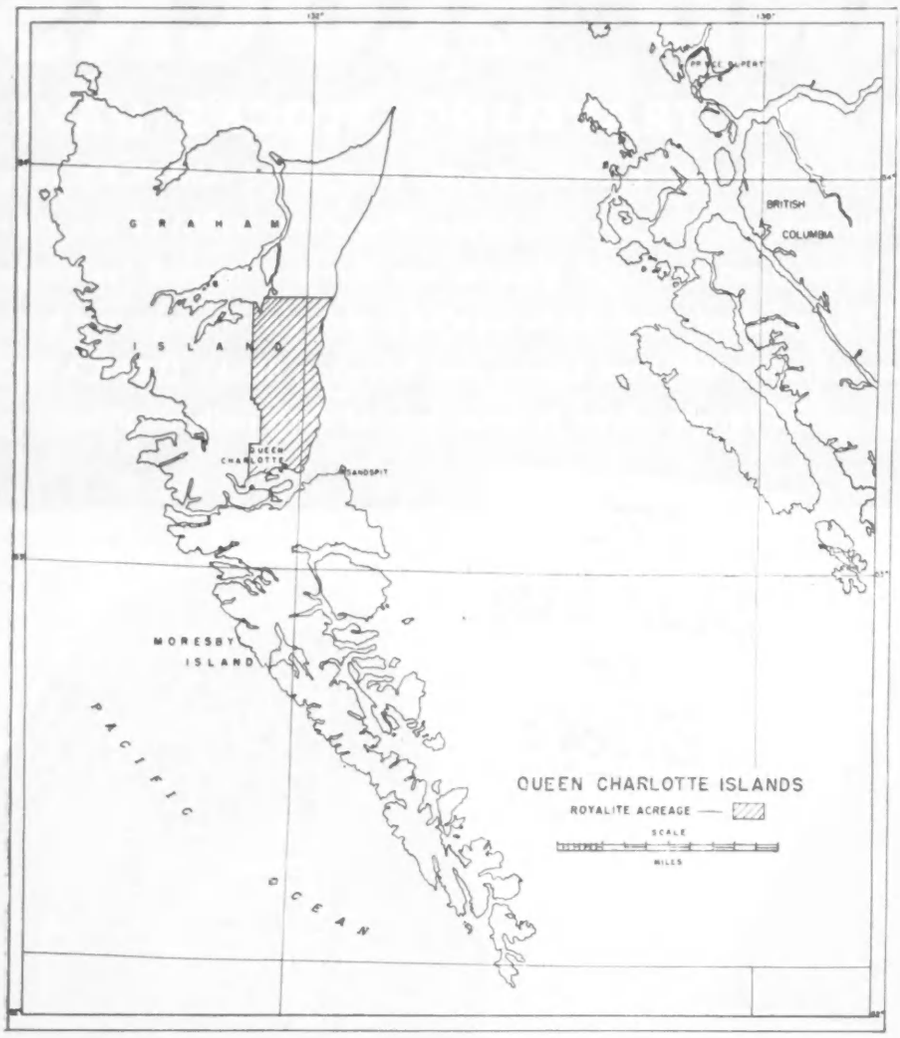

Royalite Plans Pacific Test

Royalite Oil Company, Ltd., is moving in a rig to start drilling Canada's most westerly oil test. The new wildcat will be located on Graham Island, the largest of the Queen Charlotte group off the west coast of British Columbia and separated from the mainland by Hecate Strait.

The operation will be followed with interest, since it is in an area where preliminary work over a period of years has shown oil and gas possibilities, and where discovery of oil would have a profound effect on Canada's oil economy. Thus far no oil has been found west of the Canadian Rockies.

Royalite is moving a medium-duty rig about 1000 miles by rail and water from central Alberta and will drill deep enough to test Lower Cretaceous and Jurassic formations, believed to lie no deeper than 3500 feet. There have been numerous surface indications of oil and gas observed in the area, but only one well has been drilled, a relatively shallow test taken to 1605 feet in 1914 which is reported to have had definite showings of oil and gas. Local geological conditions are said to resemble somewhat those of the Tampico district in Mexico.

Prospecting License

About three months ago the company acquired from the government of British Columbia an oil and gas reservation, or prospecting license, covering 230,000 acres in the southeastern quarter of the island. In the meantime it has done geological work resulting in selection of the location to be drilled which has been spotted on the east coast about two miles north of Skidegate Indian village, east of the town of Queen Charlotte. At this point the location is about 500 airline miles northwest of Vancouver, British Columbia, and about 155 miles southwesterly from Ketchikan, Alaska.

High Production Due From New Gas Well in Ontario

Imperial Oil, Ltd., affiliate of Standard Oil Company (N.J.), has completed what appears to be one of the largest gas wells brought in in southwestern Ontario in recent years. The well is on the farm of Roy W. Booth in Lot 21, Concession 7, Moore township. This well is about 1½ miles north and west of Imperial's Kimball gas field.

On August 3 the well was drilling ahead while making some gas. Suddenly the bit broke through a hard strata and the volume of gas quickly increased to the point where the drilling bit would no longer hit the bottom of the well hard enough to make any progress. When it was evident that the flow of gas was such that the tools had ceased to make new hole the operation of withdrawing the tools from the hole was started. The tools were withdrawn to a point about 200 feet from the top of the well. At this point the flow of gas was such that it hurled the string of drilling tools, weighing almost three-quarters of a ton, a distance of about 30 feet in the air. In passing from the top of the well the tools knocked off the control head which had been installed to control the flow of gas.

New control head equipment was quickly brought into play and the operations of bringing the well under control was started. The job of bringing this "wild well" under control was made more difficult by the escaping gas which made audible communication impossible as far as 100 yards from the well head. Ice formed on metal parts of control equipment once they were inserted into the gas stream. In spite of these difficulties a new head was successfully stabbed on the pipe and the well was brought under control shortly after 7 P.M. the same day.

While no accurate measurement of the volume of gas escaping had been made it was estimated that open flow is probably about 15 million cubic feet daily, and probable rock pressure is about 800 pounds per square inch.

Qatar Wells Show Promise Of Commercial Production

With completion of two currently drilling wells it is expected that Qatar will enter the list of commercially exporting areas shortly after the first of the year with ten producing wells to supply the pipe line which is to carry production to the Persian Gulf port. The Dukhan field was inactive for several years since the tense days of World War II which caused operators to plug the two existing wells as a security measure.

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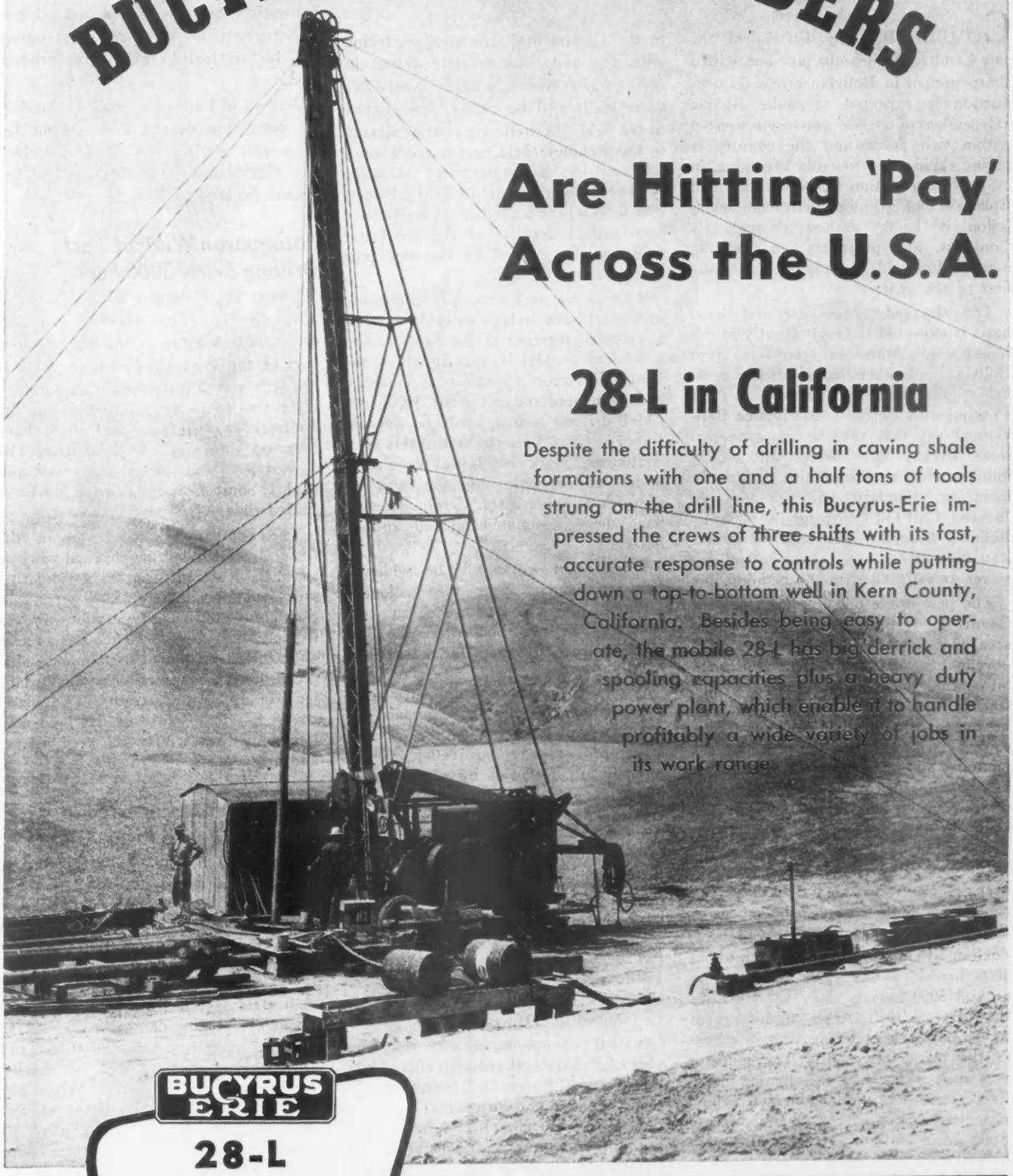

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Production and Legal Prospects Encourage Bolivian Operations

COMPLETION by Bolivia of the new Camiri-Cochabamba pipe line, with a sharp upturn in Bolivian crude oil production is expected to make Bolivia independent of outside petroleum sources within two years, and the country is taking rapid steps towards becoming an oil-exporting nation. Toward that end Bolivia's long pending petroleum legislation is being pushed through its Congress, and prospects are that the new oil law will be enacted before the first of the year.

The changed production and legal basis is expected to result shortly in the re-entry of American companies into Bolivia. Spokesmen for the Bolivian oil fields development agency, YPFB (Yacimientos Petroliferos Fiscales Bolivianos) say that preliminary conversations already have been held with a number of American major producers, including Standard Oil Company of Indiana, Gulf Oil Company and Atlantic Refining Company, and that the American operators have expressed themselves as satisfied with the pending bill.

The new crude oil pipe line from the Camiri field, Bolivia's chief producing area, to Cochabamba, will permit rapid development of Camiri. The line went into initial operation in August with a 6000-barrel a day capacity, and later will be increased to a 12,000-barrel a day capacity with the addition of two more pumping stations making a total of six in all. The line is of six-inch welded pipe, 327 miles long, with a 44-mile spur from Zudanez to Sucre. Storage facilities are being expanded rapidly. At Sucre 45,000 barrels storage tanks have been erected and 150,000 barrel tank capacity is building at Cochabamba.

Bolivia's marked upturn in crude production will lift total output from about 1000 barrels a day early this year to around 5000 barrels daily shortly after the first of 1950. April production of 59,490 barrels was 150 percent in excess of the preceding month. The increase was made possible by the opening of the Sucre extension of the pipe line which permitted pumping of gasoline from Sucre lines and storage for distribution by rail and truck, thus freeing tanks at Camiri for crude storage. May production continued the upward trend, reaching 65,769 barrels. Much of the increased production in the last few months went to fill completed sections of the Cochabamba expansion of the pipe line.

Thirteen of the 24 wells so far drilled in the Camiri field are now producing with a tested total possible output of 3000 to 3300 barrels a day. Twenty-five more wells will be drilled immediately in the field. Six wells are now producing in the Behmejo field, and a score more will be drilled in the next two years. No further drilling is planned in the Sanandita field where a total of 28 wells have been drilled. Neither of the two latter fields will be served by the new pipe line.

Two of the wells recently completed in Camiri have yielded valuable data on a western structure in the field, as has a wildcat at Mandeyapacua where the Upper Devonian formation is expected to be encountered at about 5000 feet. Chief drilling activity will be concentrated at Camiri for the rest of this year, continuing work on three wells now under way and possibly the initiation of work at other sites. Camiri reserves have been estimated at 30 million barrels.

Exploration work will be widened. During the last year the geological activities of YPFB have been concentrated in two zones. In the Los Monos structure, about 40 miles north of the Sanandita field, intensive work was carried on where preliminary activity was launched by the Standard Oil Company of Bolivia. In the Izozog structure, topographic relief studies were begun, followed by some geological work. This zone is 60 miles northeast of Camiri. Aerial mapping and further geological surveys were getting under way in October this year with the plan of drilling a test well shortly. About $500,000 in U. S. currency has been earmarked for equipment for this operation, and an additional $500,000 has been allocated for other expense. Preliminary reconnaisance and geological work also will be launched in the Caupolican and Iturralde areas.

YPFB is supplying an ever-increasing part of Bolivia's oil requirements. About 90 percent of motor fuel consumption is being supplied currently either by pumping Camiri gasoline to Sucre and distributing it by rail and truck to Cochabamba and the Altiplano, or by trucking Camiri and Sanandita gasoline to other centers. YPFB also has pumped fuel oil to Sucre. About 35 percent of Bolivia's fuel oil requirements are currently being supplied by trucking from Camiri and Sanandita, and about 100 percent of diesel oil and 50 percent of kerosine needs are being met in the same manner. Completion of the Cochabamba pipe line will make it possible to supply all motor fuel needs from local production, and when the Sucre refinery begins operation, 40 percent of the domestic requirements for fuel oil and 100 percent of kerosine consumption will be supplied from Bolivian production.

Bolivia will spend around $15 million on petroleum development during the three-year period 1946-1949, of which the Cochabamba-Camiri pipe line accounts for $6½ million.

Paraguayan Wildcat Test Drilling Below 3000 Feet

Union Oil Company of California is now drilling below 3000 feet in its Orihuela 1 wildcat in the southeastern part of the Paraguayan Chaco. This is the fifth well in the series of exploratory tests the company has drilled on its holdings in Paraguay, and there have been no showings of oil to date. The newest test is about 150 miles east and slightly south from the town of Mariiscal Estigarribia.

The company's exploration in the Chaco has included geophysical work in advance of wildcat deep tests, validating areas of approximately 25,000 acres with each completed well. Operations are extremely difficult. The Chaco has an area about equal to that of Oklahoma and is noted for its inaccessibility due to the lack of roads or streams. The brush covered, arid expanse of flat land contains only a few widely scattered villages and army posts.

Oil Shows Are Reported in Alberta's Peace River Area

Imperial Oil, Ltd., has reported the first encouraging shows of oil found in the Peace River area, Alberta. The company's Normandville 1, located about 30 miles south of the town of Peace River, is coring ahead to evaluate the productive section, but has already made a drill stem test in Devonian pay which resulted in a flow of 28-gravity oil. The test was made just below 6700 feet, of a 16-foot sand section, and oil reached the surface in 25 minutes. When pipe was pulled recovery consisted of 3500 feet of clean oil, but there were 100 feet of salt water at the bottom. Some weeks ago this well had encouraging showings of oil in the Madison limestone. A number of wells have been drilled in this general region, some showing evidence of gas, but this is the first real showing which indicates probable opening of commercial oil production.

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Government Confusion Clouds Middle East Pipe Line Status

THE recent Syrian revolution and new government in Damascus have clouded, for a time, the status of the broad Middle East pipe line program. Apparently the Iraq Petroleum Company's new 16-inch line to Tripoli is not adversely affected, but other lines include the Trans-Arabian Pipeline Company's line now building from the Saudi Arab fields to Sidon, Lebanon, and the proposed Middle East Pipe Lines, Ltd. project from the Iranian fields to the Syrian coast.

Since the IPC project is merely an expansion of existing facilities, and the Middle East line is not yet beyond the blueprint stage, greatest concern centers on the line of Trans-Arabian (TAPline), which is out about 300 miles from the Persian Gulf and on which work was scheduled to begin at the western end in September. TAPline, an operating subsidiary of Arabian American Oil Company (Aramco), had recently signed its long-delayed convention with Syria for transit rights for the 1067½-mile line, of which length only about 100 miles will cross Syrian territory. This convention signed with the former Zayim government may be invalidated or revised by the new revolutionary regime of Colonel Sami Hennawi. After the revolution and the execution of Zayim, the new Hennawi cabinet began revoking a series of acts passed by the preceding administration. However, no general revocation edict was issued, but Hennawi announced that all decrees of the former Zayim junta would be reviewed one by one. This procedure leaves undertermined the fate of TAPline until official cabinet action is taken.

The only clue as to possible action that may be taken was contained in the following communique from the Hennawi cabinet: "In respect to foreign policy the government will see that its relations with foreign states will be those of courtesy and friendship within the limits of national interest and within the limits of the United Nations charter, and in accordance with international law."

The question thus posed is whether TAPline is an international obligation assumed by a duly-constituted Syrian government, observance of which is mandatory under international law. Foreign Minister Nazem el Kodsi hinted that TAPline might be recognized as an international obligation. However, strong pressure, directed by Communist and other radical groups, has been brought to bear on the Syrian government against dealing with "foreign oil imperialists."

Meanwhile, TAPline prepared to proceed with line construction at the western end, out of Beirut, Lebanon. The first shipload of supplies for this part of the job reached Beirut in July, about 4000 tons of construction equipment and material. Included in the shipment were trucks, tractors and cranes to handle the 31-foot lengths of pipe. First pipe delivery was made in Beirut early in September.

Aramco has slightly reduced its personnel of 2700 in Saudi Arabia and announced plans to take in a thousand Arab refugees from Palestine for nontechnical work at the fields.

The World Bank recently began its large-scale lending program to the Middle East in a vast undertaking to promote industrial development of five countries and to raise the living standards of millions of people. The first loan was made to India, $10 million for railroad development. Other countries due to get grants this year are Turkey, Lebanon, Egypt, Iran and possibly Iraq. This whole program up to the end of this year will exceed $100 million.

Most of the Middle East projects involve transportation, power and irrigation enterprises. Heavy sales of American equipment are expected over the next few years all through this region.

The London *Economist* reports that a "conservative estimate" of oil company royalties to, and expenditures in these Middle East countries will total $6 billion over the next ten years. While projects in the early years will cost more than the annual intake from oil royalties, expanding European markets in later years will justify the heavy investments, it is expected.

Burmah Oil Needs Burma Cash, Company Chairman Declares

Difficulties attached to operations in Burma are pointed up in a recent statement by Burmah Oil Company's board chairman Sir Kenneth B. Harper, who indicated that the hope for continuation of the activities of the oil industry within a reasonable time lie in the possible participation of the Burmese government in the financial structure of the company.

The company has been operating under a special exception since adoption of the new constitution of Burma in January, 1948, but internal disturbances have made further outlay of capital too hazardous for it to continue as a strictly business venture.

The constitution contains a clause providing that natural resources of the country be in the hands either of the state or of corporations having a majority of Burmese capital. The special exception granted to Burmah Oil Company had not been fully settled upon officially when internal revolt caused virtual stoppage of work. Meanwhile, the government proposed a plan under which the company would submit a framework by which the government could participate in the company and furnish funds to continue the work. Such a proposal has been submitted.

Meanwhile, no exploration work can be carried out under present conditions, although reconstruction in the producing fields has progressed to the point where it would soon have been possible to make more petroleum products for the local market and save some exchange now going for Middle East oil.

Recently announcements have been made by the Burmese government that the fields in the Yenangyaung area, evacuated by British personnel under pressure from the rebels, would continue to operate under direct state control and that a group of oil experts were to be moved in at once to begin operations. The government's immediate concern to continue work there is presumably the uninterrupted employment of about 2000 Burmese workers, plus the saving in foreign exchange if enough production for local needs is developed.

For some time the civil war has virtually isolated the fields from their outlet to the sea. The pipe line to Syriam was shut down most of the time because of persistent interference and because of the difficulty of coordinating runs with the unreliable Irrawaddy River tanker service. Field production most of the time was limited to the capacity of a small refinery in the fields which produced gasoline and illuminating oil for distribution to up-river points. The Syriam refinery is operating almost entirely on Middle East crude from Iran and Kuwait other than its use as a storage depot for what oil comes through from Yenangyaung or Chauk.

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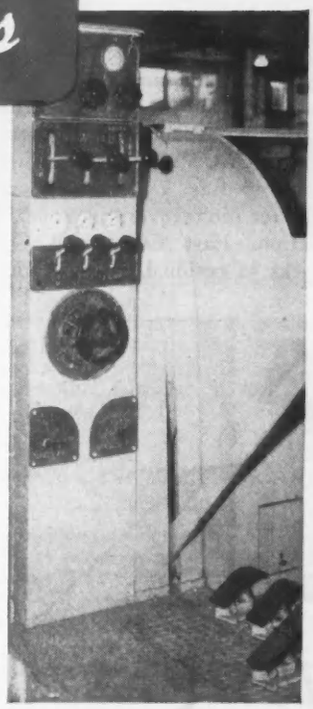

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Venezuelan Crude Production Achieves Record Daily Rate

Venezuela's crude production reached an all-time record of 1,442,000 barrels daily in September, an increase of 25 percent over the year's low of last May, and an increase of 4.5 percent over the previous record of 1,383,000 barrels a day, reached in October, 1948.

Cutbacks in Venezuelan output beginning late last year were occasioned by slowing up in demand for heavy oils, and production curtailment in Venezuela was chiefly in the heavy-oil area of Lake Maracaibo. Rising demand on the Atlantic Coast, and increasing fuel oil shipments to East Coast ports, are responsible for the recovery in Venezuelan production. East Coast and Gulf Coast stocks of residual oil are about 20 percent lower than last year. Residual imports may run 50 percent above levels of last winter, and some companies estimate that they may reach 275,000 barrels daily, or 85 percent above last year's mark.

Increase in Venezuela production is due chiefly to stepped up operations by the Shell Group. In fact, Creole Petroleum Corporation, largest Venezuela producer, is still running somewhat below output of a year ago, although production is now about 615,000 barrels a day. Shell's August production total was 494,000 barrels a day, up 50,000 barrels daily, and up 20,000 over its last record in 1948.

John A. Walstrom, vice president of Asiatic Petroleum Company (Shell) testified in New York last July before a House Small Business Committee investigating imports, that his company plans to increase imports of residual from 47,000 barrels a day to 75,000 barrels a day, beginning in 1950. This program may be accounting for Shell's production stepup in Venezuela.

Meanwhile, Venezuela Gulf Refining Company is building a 30,000-barrel a day refinery at Puerto La Cruz, Venezuela, at a cost of $50 million. The plant is scheduled to begin operations in mid-1950. The crude for processing will be supplied two-thirds by Gulf companies and one-third by The Texas Company subsidiaries. When in full operation the refinery's yield will be about 11,000 barrels daily of gasoline, 7600 of No. 2 fuel oil and diesel fuel, and 10,500 of residual fuel. It is planned to sell the plant's entire output in the world's markets.

The new plant includes a crude oil distillation unit, a polyform unit, gasoline and diesel oil treating equipment, and steam and electric generating plants. Gulf's subsidiary, Mene Grande Oil Company, will double the capacity of its docking facilities to permit berthing four tankers at a time to load crude or product.

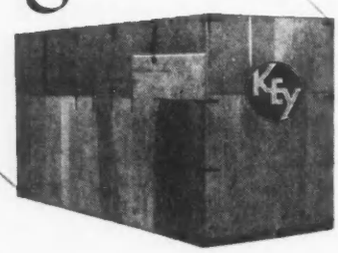
New Pipe Line Would Carry Refined Products to Toronto

Imperial Oil, Ltd., British-American Oil Company, Ltd., and McCall-Frontenac Oil Company, Ltd., are reported to have joined in the organization of a pipe line enterprise to be known as Northern Pipe Line Company, Ltd. The group is expected to spend $10 million in the construction of a line to carry refined products from Montreal, Quebec, via Ottawa, to Toronto, Ontario.

Montreal is a refining center which is supplied by crudes of Gulf Coastal and Caribbean origin through 236 miles of 12-inch pipe line running from Portland to Montreal, thus saving the long ocean haul around the Maritimes and up the St. Lawrence River.

Gracious Living...

PACKAGED FOR EXPORT



Personnel of Companies Operating In Foreign Fields Now Given Chance To Live In New Comfort...

No longer is it necessary for company personnel to live in clapboard shacks or depend on foreign housing. Key Contractors offers this smart, modern, insulated aluminum house especially designed for export and tropical use.

Each house is complete in every detail, right down to the doorbell and soap dish in the bath. After Key is finished only the utilities need be connected and personal furniture moved in to make this charming house a completely livable home.

Complete 3-bedroom house shown above may be packaged in 8' x 10' x 22' crate, weight approximately 16,000 pounds, to be shipped and erected anywhere in the world.

Look At These Features...

- Fixed and casement type steel sashes, fully glazed.
- Vermin and insect proof.
- Low cost maintenance.
- Large wardrobes and cabinets.
- Easy to disassemble and move to another location.

Here's How KEY Does It...

Each house is completely erected to double check each part before crating. All skilled work such as plumbing and wiring is done before the house is shipped. The house is erected upon arrival on concrete slab by local labor under Key supervision in approximately 400 man hours.

EXPORT REPRESENTATIVES: E. L. CARTER, 30 Rockefeller Plaza, New York 20 — VIC INDIG, 1201 Russ Building, San Francisco 4

MAIL THIS COUPON FOR MORE DETAILS

KEY CONTRACTORS, INC.

Phone: Whittier 44637 • P. O. Box 356, Santa Fe Springs, Calif.

NAME_____

POSITION_____

COMPANY_____

ADDRESS_____

NEW AND IMPROVED Equipment SUPPLEMENTING COMPOSITE CATALOG

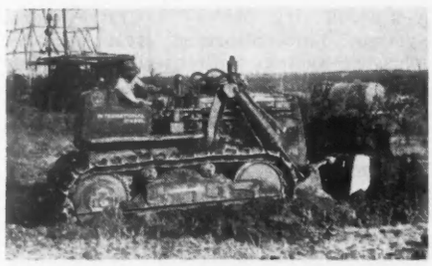
New and improved equipment of manufacturers who describe their products or services in the current Composite Catalog

271—Diesel Crawlers

This item supplements International Harvester Company data as shown on pages 2537-2540 of Composite Catalog, 17th Edition.

The new heavy-duty TD-18A diesel crawler has 87 drawbar horsepower, compared with 80.5 in the previous model. Net engine horsepower at the flywheel, which was 97 in the last model, is now increased to 107. Belt horsepower, previously 91.5, has been raised to 101.

Drawbar pull is at a new high of



22,400 pounds in first gear with engine operating at maximum torque. The drawbar has been strengthened by welding, in addition to riveting and 20-inch shoes are now standard. This model has six speeds forward, to a high of 5.7 miles per hour, and two reverse, up to 3.5 miles per hour.

In the TD-14A, third largest of the crawler line, horsepower is 76 at the engine flywheel; 60.5 drawbar, and 72 belt. This tractor has higher maximum drawbar pull of 16,600 pounds in first gear. The TD-14A has the same speeds as the TD-18A.

Both tractors have spring boosters on the steering clutch, and a closed cooling system which prevents loss of coolant when the tractor is working on a steep grade, and also helps maintain proper engine temperature.

An air-tight radiator cap and a low-pressure valve in the overflow pipe, seal the cooling system and prevent liquid from spilling. The valve opens under slight pressure, so that steam is released and the engine will not overheat.

Other newly-designed parts include crown-shaved transmission and final drive gears; spiral bevel gears; improved engine clutch hand levers; bonded clutch facings; dowel bolts in sprocket gears; split type steering clutch couplings, and steering clutch pilot bearings with staked nuts. Transmission gear shifts are equipped with a positive lock to prevent gear "pop-out" under heaving going. A glass water trap in the diesel fuel system permits operator or mechanic to determine service needed.

For additional information, write Consumer Relations Department, International Harvester Company, 180 North Michigan Avenue, Chicago 1, *referring to* WORLD OIL *item* 271.

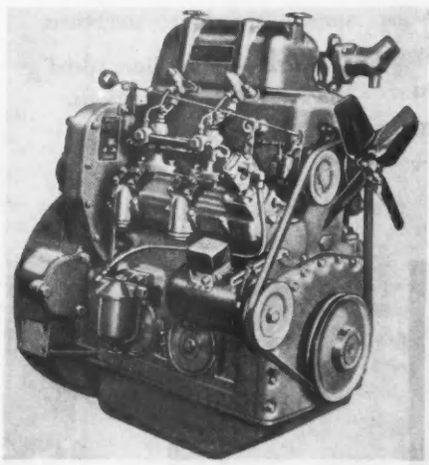
272—Two Cylinder Diesel

This item supplements Harnischfeger Corporation data as shown on page 2177 of Composite Catalog, 17th Edition.

A new two-cylinder, two-stroke, high speed diesel engine has the patented P&H cylinder head and liner assembly, with 4½-inch bore by 5½-inch stroke. The cylinder head is interchangeable from one engine to another and is removable in a period of 40 minutes. Liners are of hardened steel alloy and the assembly is completely water jacketed and cooled. Water travels upward in the liner and passes between each intake port to control the temperature at that point.

Intake ports are machined on a compound angle to send the air from a root-type blower into the cylinder in a swirling motion.

The engine is 28¼ inches wide, 40⅞ inches high, and 32¼ inches long. Weight, complete with cast light metal alloy block, is 1030 pounds with a horsepower rating of 52.5 at 1400 revolutions per minute. It operates on a 16 to 1



compression ratio with a displacement of 174 inches.

For additional information, write Diesel Engine division, Harnischfeger Corporation, 100 Laks Street, Port Washington, Wis., *referring to* WORLD OIL *item* 272.

273—Valve and Flame Arrester

This item supplements Black, Sivalls & Bryson, Inc., data as shown on pages 717-748 of Composite Catalog, 17th Edition.

The patented VVH pressure-vacuum vent valve is combined with a flame arrester bank which acts to prevent propagation of flame into storage tanks con-

taining volatile liquids.

Highly inflammable liquids stored in atmospheric pressure tanks present a constant fire hazard. The installation of a flame arrester as part of the vent valve decreases this hazard by keeping any outside flame from entering the tank through the vent valve. The danger of fire is greatest when the tank is venting, releasing volatile vapors into the atmosphere. When a flame arrester bank is employed with the vent valve, flame resulting from a flash of lightning or from fire near by is prevented from flashing back into the tank.

The flame arrester bank fits into the throat of the VVH pressure-vacuum vent valve and becomes an integral part of the valve body. The arrester bank, of rolled aluminum construction, can be removed for cleaning or replacement by releasing the retaining ring spring. Rubber-to-metal sealing makes the valve tight and prevents it from freezing shut.

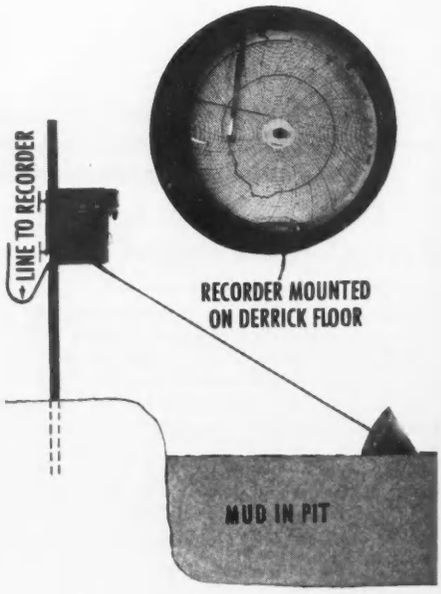
For additional information, write Black, Sivalls & Bryson, Inc., 720 Delaware, Kansas City 6, Mo., *referring to* WORLD OIL *item* 273.

274—Pit Level Indicator

This item supplements Petroleum Instrument Company data as shown on pages 4100-4101 of Composite Catalog, 17th Edition.

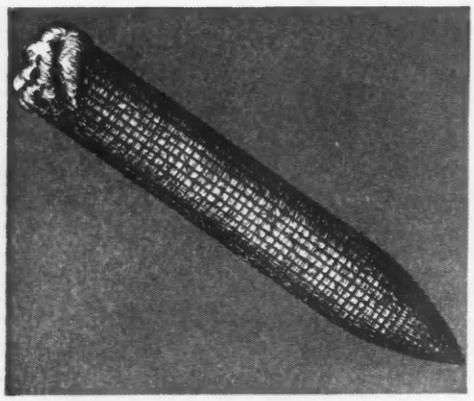
An instrument for measuring and recording the level of a mud pit is designated as the Automatic Pit Level Indicator and Alarm System. The instrument warns the driller instantly of changes, either upward or downward, in the level of the fluid in the pit. Should the well begin to unload, the level of the fluid in the pit would rise and cause the instrument to sound the alarm. Conversely, should the formations begin taking an abnormal quantity of drilling fluid, which would diminish the mud returns and cause the level of the pit to lower, the alarm would also sound.

The system is self-contained and has



a six-volt dry battery operated alarm system. The calibrated float operated pressure system with the alarm system and battery is mounted on a two-inch standpipe driven into the ground or mounted on the pit as illustrated. The recorder is mounted on the derrick floor in front of the driller.

For additional information, write Petroleum Instrument Company, 2200 West Alabama, Houston, *referring to* WORLD OIL *item* 274.



Don't risk Bottom Water shutdowns

Eagle-Picher Lead Wool
shuts out Bottom Water!

Prevent costly shutdowns, keep bottom water out of your wells with effective, economical Eagle-Picher Lead Wool. The fine, durable strands fill cracks and crevices with a permanent, non-corrosive seal...save you time and money. Packed in convenient 50-pound sacks — easy to place in special cartridge-shaped Eagle-Picher Wire Containers sized to fit all casings. Order through your jobber today!

These 3 Eagle-Picher Bearing Metals meet most requirements

Dreadnaught — for extreme speed and heavy-duty conditions.

Outlasta — for medium speed and average-load conditions.

Durable—for low speed and light-duty conditions.

EAGLE-PICHER LEAD WOOL
Seals off Bottom Water— keeps 'em flowing!

THE EAGLE-PICHER COMPANY
Since EP 1843
Cincinnati • East St. Louis
Chicago • Kansas City • Dallas

275—Swivel

This item supplements International Derrick & Equipment Company data as shown on pages 2477-2536 of Composite Catalog, 17th Edition.

A tandem arrangement distributes the operating load equally over the "dual" main bearing of the model DSS-300 swivel, permitting 300 tons operating capacity at 100 revolutions per minute.

The swivel body design forces oil to be circulated through the bearings when the swivel is rotated. Ideco full floating washpipe assembly and quick-change packing cartridge are used.

For additional information, write International Derrick & Equipment Company, P. O. Box 1331, Dallas 1, *referring to* WORLD OIL *item* 275.

OIL and GASOLINE FIRES
quickly reached . . . instantly smothered!

NEW—
high speed, high volume
WALTER
FIRE FIGHTER

QUICK FACTS—

Fire Fighting Equipment

Carries 1,000 gal. of water, 90 gal. of foam liquid for mixing, 800 lbs. of carbon dioxide. Equipped with two turret jets, three ground-sweeping jets and three handline jets which discharge a total of 4,800 gal. of fog-foam which blankets, smothers and seals the fire in a matter of seconds. Two auxiliary 140 hp. motors operate pumping system. Also equipped with metal ladders, metal cutting equipment and hand extinguishers.

Truck Chassis

Mounted on 240 hp. Walter Tractor Truck, with Four-Point Positive Drive. This assures 100% traction to reach any location through soft dirt, sand, mud, snow, slippery surfaces and steep grades. Accelerates to 45 mph. in one minute. Entire unit weighs 42,000 lbs. Large single tires, size 16:00-24, provide added rolling ability in bad running conditions. Power hydraulic steer, air brakes.

WALTER
4-POINT POSITIVE DRIVE
TRACTOR TRUCKS

EVERY OILFIELD OR REFINERY FIRE is a potential disaster. Speed in reaching the scene and in controlling the fire, are absolutely vital. This powerful, super-traction Walter Fire Fighter gives you a giant, mobile "fire extinguisher", ready at an instant's notice to speed to any outbreak through sand, slimy mud, snow or other difficult running conditions and quickly smother the fire in an overpowering blizzard of fog-foam.

Walter Fire Fighters incorporate the latest, approved fire-fighting techniques and have recently been adopted for airport rescue and fire control work at the largest airports in the world.

WALTER
Water and Foam Supply Truck

• Mounted on 240 hp. Walter Tractor Truck, carries 2,500 gal. of water and 250 gal. of foam liquid, furnishing additional supplies if needed. Useful for general fire protection, also.

Write for full information on these units

WALTER MOTOR TRUCK CO.
1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N. Y.

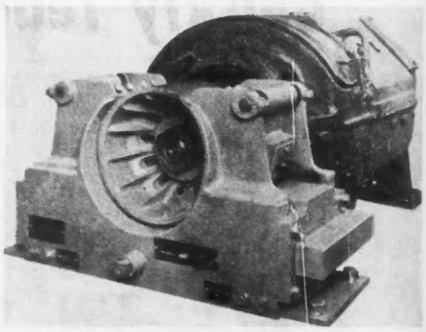
NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

276—Two-Magnet Brake

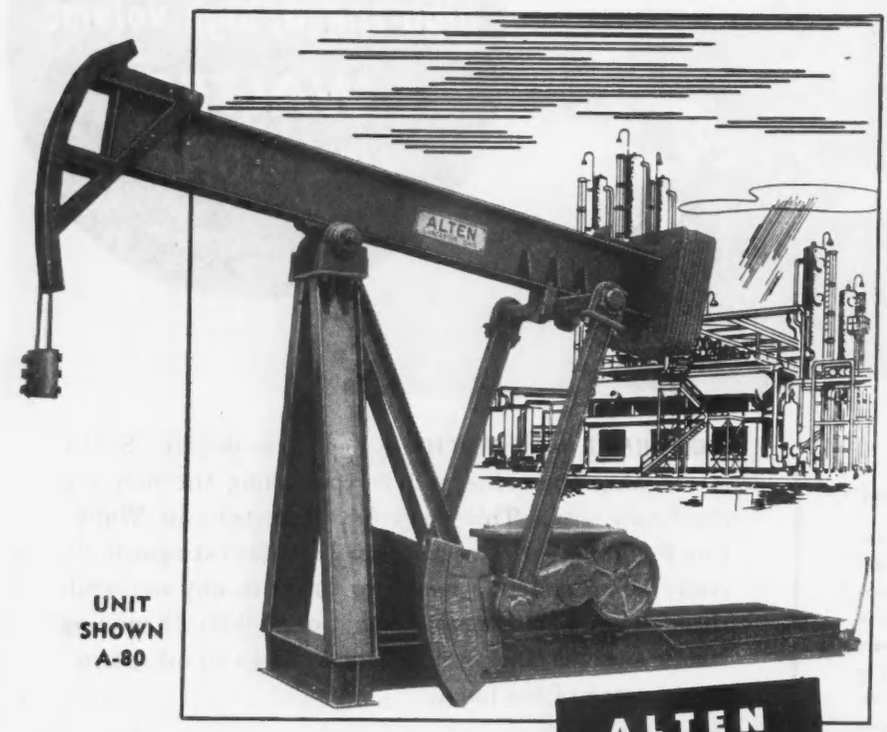
This item supplements General Electric Company Apparatus department data as shown on pages 1809-1820 of Composite Catalog, 17th Edition.

A new direct-current two-shoe, two-magnet brake is designed for use on steel mill drives, cranes, hoists, bridges, conveyors, and for general marine service. It consists of a malleable iron frame, two self-aligning shoes which pivot on spherical bearings, two armatures pivoting on sealed graphite bearings, two symmetrical E-type magnets with cast-in coils, and a ventilated wheel of molybdenum alloy. The iron frame protects all moving parts. Universal ball joints protected by neoprene sleeves permit self-alignment of shoes and insure uniform lining wear, and a quick-release mechanism, which responds to a wrench, permits removal of wheel, horizontally or vertically, or changing brake linings without disassembling any part. The cast-in coils are sealed in a heat-resisting insulating compound.



The torque-setting indicator gives a direct reading of foot pounds torque setting and the clearly marked operating gap indicator provides a ready visual check on magnet gap and lining wear. The brake is applicable for either right- or left-hand mounting, either on the floor or, with brackets, on motors.

For additional information, write General Electric Company Apparatus department, Schenectady 5, N. Y., *referring to* WORLD OIL *item* 276.



UNIT SHOWN A-80

ALTEN PUMPING UNITS

Built to take it-

We don't put Alten Units together like a Swiss watch. They're not built to keep time—but keep PUMPING. No useless, fancy frills; but all the best of alloys, gears and bearings where strain and wear get in their licks. For work-horse efficiency, look to Alten.

Also Casing Heads, Stuffing Boxes, Stop Cocks and other production items.

A-80 FEATURES

★Rigid, all-welded steel Samson Post, Frame and Beam. Structural rating: 7,500 lbs.

★Quality Gear Reducer. Hardened alloy gears and pinions. Roller-bearing equipped. Double reduction ratio: 28.4:1. Torque rating 44,550 in. lbs.

★Adjustable stroke length: 22" to 36".

★Wrist Pin and Equalizer has double-row, spherical, self-aligning roller bearings.

ALTENS
FOUNDRY & MACHINE WORKS, INC.
Lancaster, Ohio
Established 1889
Ask for Name of Nearest Dealer

277—Gauge Illuminator

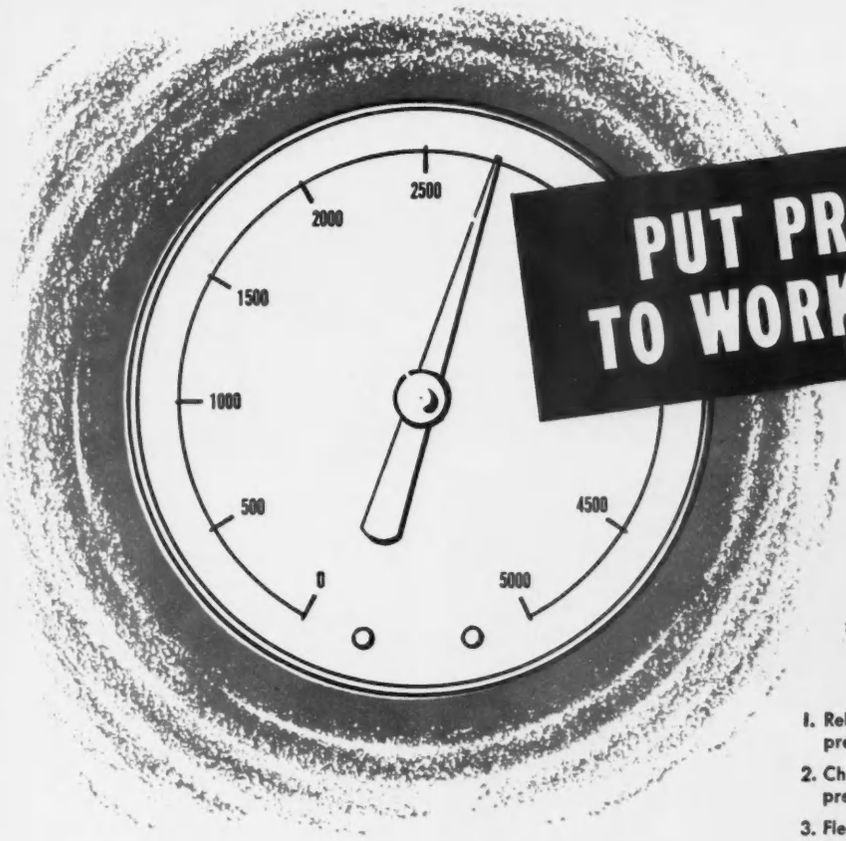
This item supplements Jerguson Gage & Valve Company data as shown on page 2553 of Composite Catalog, 17th Edition.

Evenly diffused light over the entire length of a gauge glass is provided by the Solid-Wedge Type Gauge Illuminator.

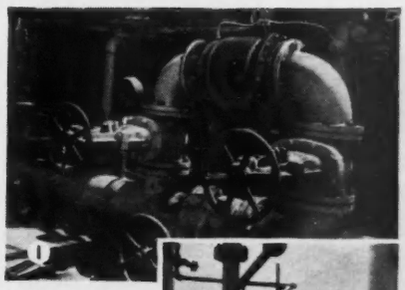
Solid-wedge lighting is combined with plastic, whereby the illumination from a single light source is reflected from an angular surface and flows with evenly diffused intensity through the transparent gauge glass.

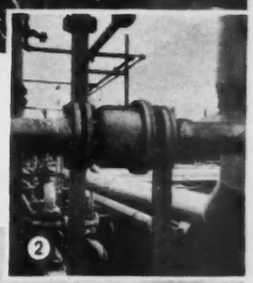
Illuminators are made in explosion-proof and standard models for all sizes of transparent gauges, and in single and double section styles. Lighting is by a standard small bulb. Aluminum brackets are furnished for mounting on the top two cover bolts of the gauge section.

For additional information, write Jerguson Gage & Valve Company, 80 Fellsway, Somerville 45, Mass., *referring to* WORLD OIL *item* 277.

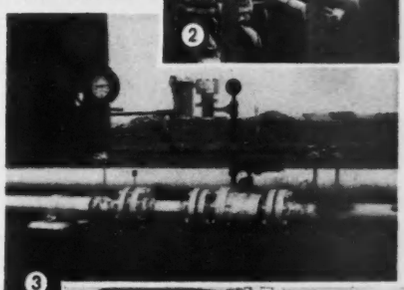


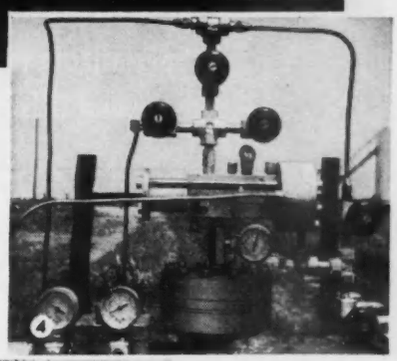
PUT PRESSURE TO WORK FOR YOU





1. Reliever holding back pressure on gas line.
2. Chexflo in gas compressor discharge line.
3. Flexflo automatic shut-off in gas line to heater.





4. Well Head Protection System, T-series Seat-Seal Valves in manifold.
5. Model 899 Separator Oil Valve.

by standardizing... on GROVE valves and regulators

Properly controlled and applied fluid pressures, rather than the mechanical forces of springs, weights or packings, are the outstanding features that characterize Grove designs and products.

The Grove Powreactor Dome principle has revolutionized the design and construction of regulators for high pressure gas, air and other fluids, by eliminating cumbersome springs, weights and levers.

Flexflo and Chexflo valves, resulting from Grove studies of the action of enclosed expanding tubes, effect a positive and unfailing operation never before achieved in the control of pipeline fluids.

The "O" ring Seat-Seal principle, embodied in "T" and "V" series globe-type valves and "F" and "M" series slide valves, has greatly increased the field of usefulness and the pressure ranges of these valve types.

The products illustrated are only a few examples of the flexibility and adaptability of all these exclusive Grove developments. For your control problems, too, Grove can provide regulators and valves of unequalled reliability. Contact the nearest Grove office today, or address your inquiry to:

GROVE REGULATOR COMPANY
65th & Hollis Street, Oakland 8, California

3608 Navigation Blvd., Houston, Texas
310 Thompson Bldg., Tulsa 3, Oklahoma
1930 W. Olympic Blvd., Los Angeles 6, California
205 E. 69th Street, New York 21, New York

GROVE — GROVE "PUTS PRESSURE TO WORK" — **VALVES and REGULATORS**

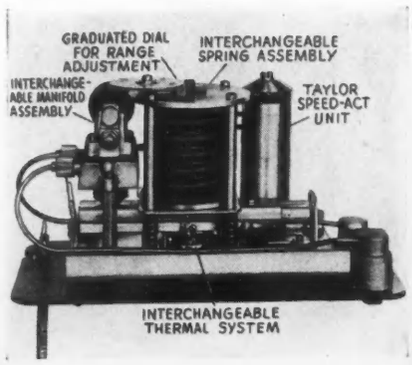
278—Temperature Transmitter

This item supplements Taylor Instrument Companies data as shown on page 4650 of Composite Catalog, 17th Edition.

A new force-balance type pneumatic temperature transmitter called the Transaire with Speed-Act is designed for applications where it is desirable to have the indication, record or control remotely located from the point of measurement, and where it is necessary to have small thermal elements and short range spans within the limits of minus 375° and plus 1000° F.

The Speed-Act principle overcomes the lag inherently present in the response of any form of thermal measuring element, the manufacturer claims.

Output in pounds per square inch is proportional to the temperature of its



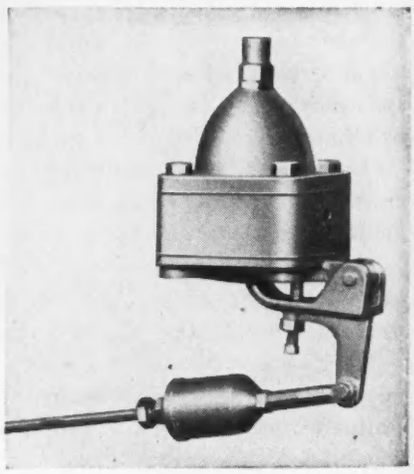
thermal element, and by means of one-fourth inch copper tubing, this pressure change can be transmitted to a recording or controlling receiver as far as 1000 feet away.

For additional information, write for Bulletin 98140, Taylor Instrument Companies, 38 Ames Street, Rochester 1, N. Y., *referring to* WORLD OIL *item 278.*

279—Regulator

This item supplements Ingersoll-Rand Company data as shown on pages 2465-2472 of Composite Catalog, 17th Edition.

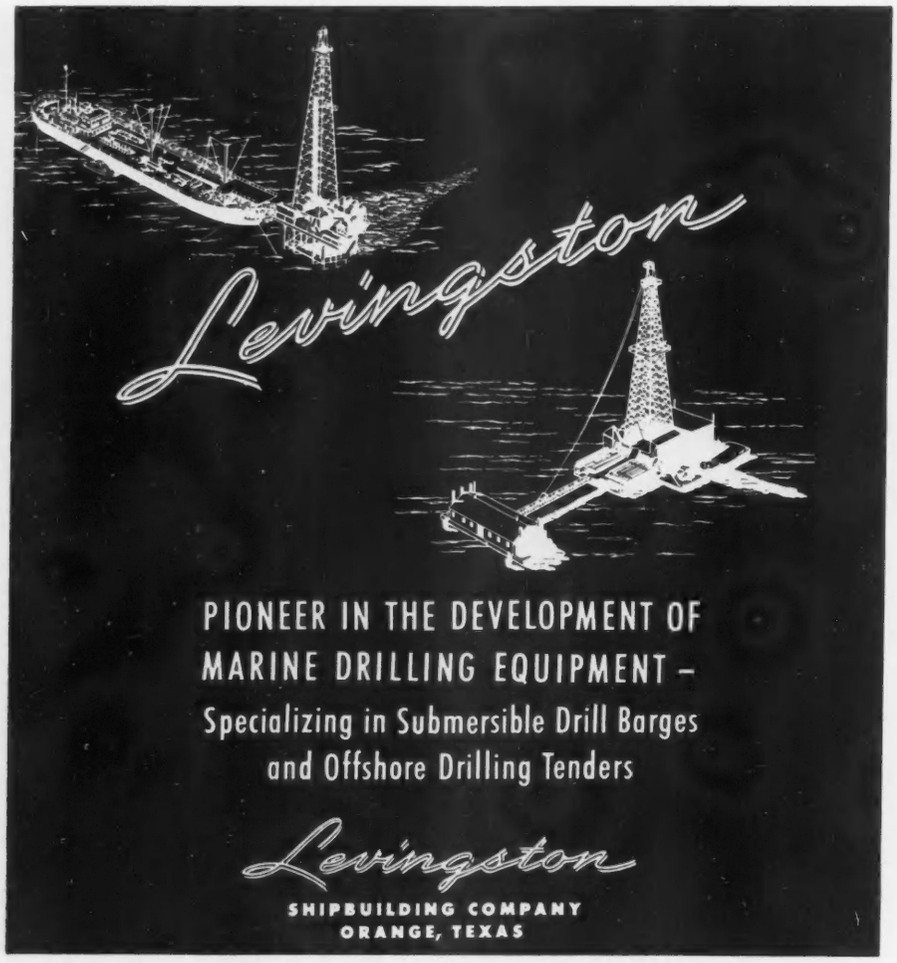
Whenever less than full capacity of a portable compressor is used, the "Floating-Speed" regulator slows down the compressor to the lowest practical working speed that compresses just enough air to hold the pressure. When the air

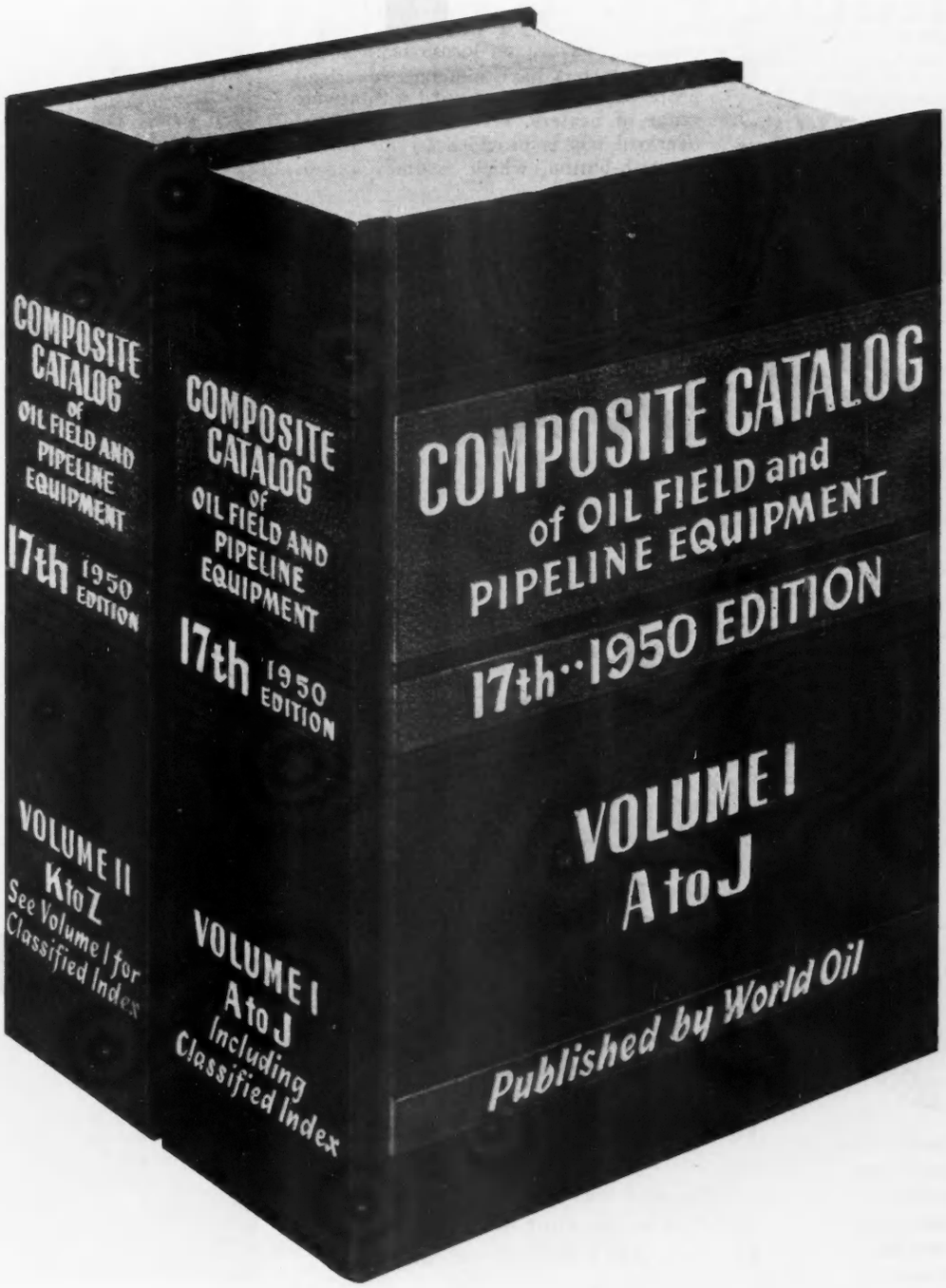


demand changes again, the speed "floats" up or down to the exact speed required. The compressor capacity is varied throughout the entire speed range without speed steps or cycling.

Compressor cylinders unload only when the minimum speed delivers more air than needed. After reloading, the compressor continues to operate at low speed unless a greater use of air causes it to speed up. The new UL-83 automatically varies the speed by adjusting the engine governor spring.

For additional information, write Ingersoll-Rand Company, 11 Broadway, New York 4, *referring to* WORLD OIL *item 279.*





USE THIS UNIVERSAL EQUIPMENT GUIDE

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

280—Manual Starters

This item supplements General Electric Company Apparatus department data as shown on pages 1809-1820 of Composite Catalog, 17th Edition.

Manually operated starters for alternating current motors up to 7½ horsepower are available in either toggle or push-button types, in 2-, 3-, and 4-pole forms, sizes 0 and 1. Toggle operated types can also be furnished with cast iron enclosures for use in wet, dust-laden, or hazardous locations.

The starters have bimetallic overload protection, and are equipped with a wide range of heaters. Positive indication of overload trip is provided by the toggle or push-button, which assumes a neutral position when the relay trips. Starters in general purpose enclosures can be padlocked.

Live parts are mounted on a strong molded base. Heaters are enclosed in a cavity in the molded base to protect the operator in event of short-circuit.

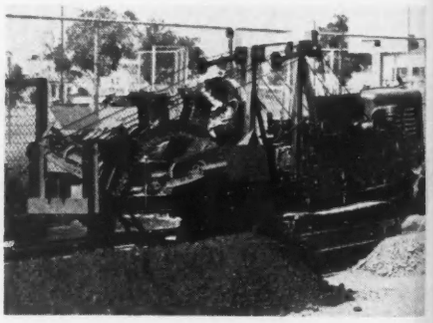
For additional information, write General Electric Company Apparatus department, Schenectady 5, N. Y., *referring to* WORLD OIL *item* 280.

281—Small Trencher

This item supplements The Cleveland Trencher Company data as shown on page 1242 of Composite Catalog, 17th Edition.

A compact trenching machine, the "Baby Digger Model 92," is especially adapted for small trenching jobs, such as for laying power cable and conduits. Small size of the trencher allows adequate maneuvering in tight places.

The machine is moved from job to job on its own rubber-tired tilt-bed



electric braked trailer. Ditch capacities range to five feet deep and 10 to 20 inches wide. Crawler tracks are clog-proof. The power-ship conveyor is operator controlled, giving instant control of the spoil bank. The crumbing shoe can be swung up and away to permit digging next to foundations, walls and trees.

For additional information, write for bulletin S-53, The Cleveland Trencher Company, 20100 St. Clair Avenue, Cleveland 17, *referring to* WORLD OIL *item* 281.

Sign Here

PREFABRICATED 30 Years HOME MANUFACTURER

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF JOHNS-MANVILLE BUILDING MATERIALS; CURTIS WOODWORK

Yes, ONE purchase order from you enables Southern Mill to transport and erect one house or an entire oil field camp on any site you specify. You pick the designs you want . . . we do the rest. Save time and money, and have unusually attractive homes for your workers. Specify STURDYBILT for any oil housing you need.

STURDYBILT

SOUTHERN MILL & MANUFACTURING CO.

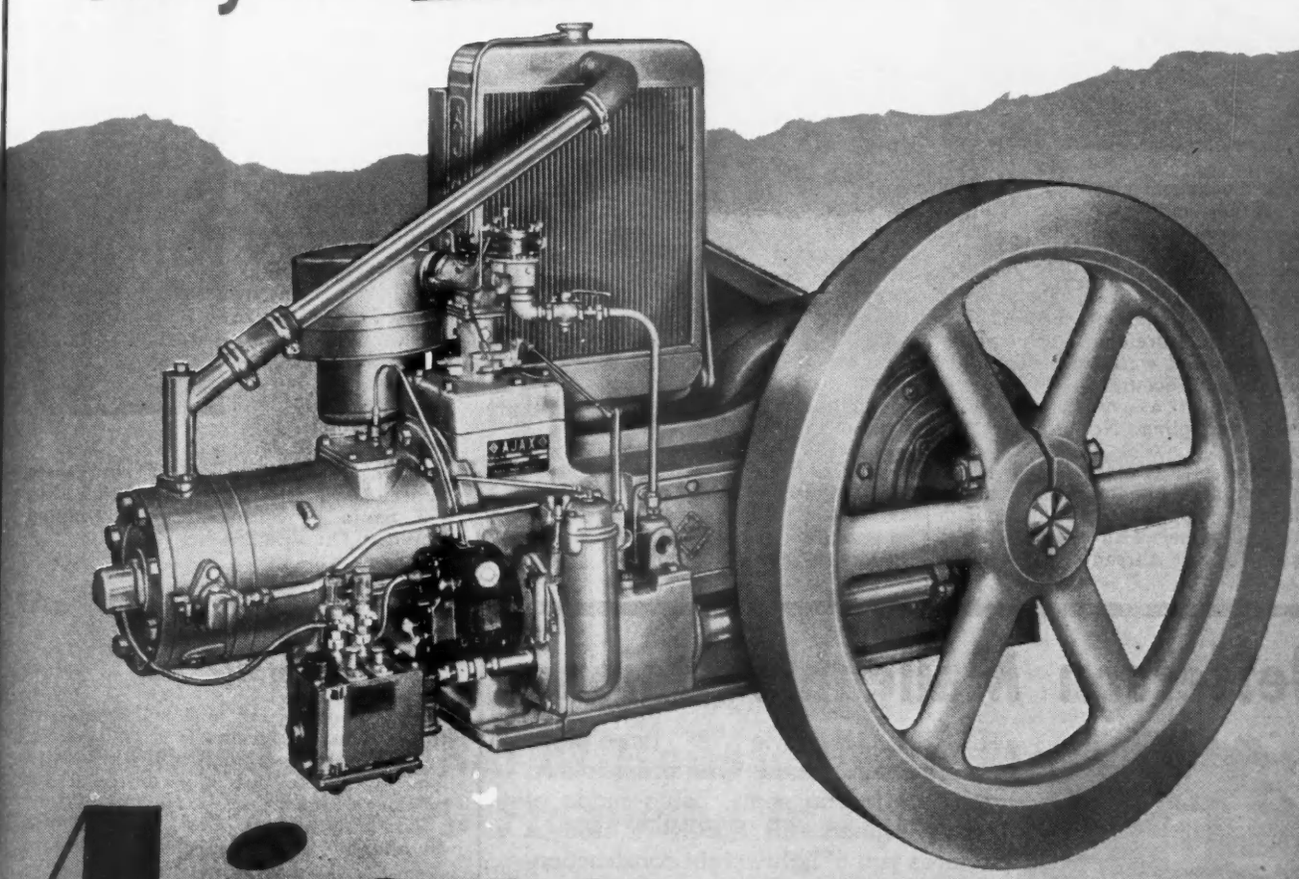
Tulsa, Oklahoma

Prefabricated, Demountable Houses

phmi PREFABRICATED HOME MANUFACTURERS INSTITUTE

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

DEPENDABLE LOW-COST OPERATION
for your TOUGH, CONTINUOUS jobs



Ajax GAS and OIL ENGINES

- Long Life
- Low maintenance
- No oil contamination
- Double-row frictionless bearings
- Modern design

AJAX Engines are simple and sturdy. They keep on rolling month in and month out. You don't have to worry about them or baby them; they do the jobs they're built to do. • Behind such performance is the fine engineering you'd expect AJAX to apply . . . fine materials, and fine craftsmanship. *Check the details with your Supply Man!*

AJAX IRON WORKS
CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., TOLEDO, OHIO
R. B. MOORE SUPPLY CO., INC., BOLIVAR, N. Y. · BETHLEHEM SUPPLY CO., TULSA, OKLA.

OTHER NEW AND IMPROVED *Equipment*

282—Electrical Coupling

A quick disconnect electrical coupling for all-weather and submarine applications is impervious to moisture and capable of withstanding long periods of complete immersion under high external pressure without leakage. Results of tests on Navy equipment showed that with external pressure conditions equivalent to 1150 feet of water, no leakage or moisture seepage occurred.

A quarter-turn assembles or disassembles the coupling. No tools are required.

Standard electrical inserts used in the coupling employ phenolic material of high dielectric qualities. The couplings are provided either with pressure tight cable seals or are threaded for attachment to conduit, bulkheads or panels. Bronze alloy is the material used in the couplings, and aluminum alloy and stainless steel are also available.

For additional information, write Roylyn, Inc., 718 West Wilson Avenue, Glendale 3, Calif., *referring to* WORLD OIL *item* 282.

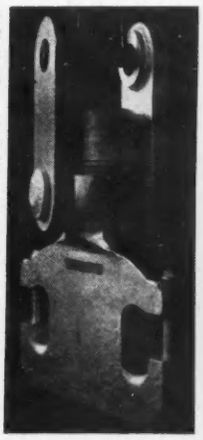
283—Petroleum Meter

All-steel, positive-displacement BiRotor meters have interchangeable measuring unit assemblies comprised of two synchronized helical rotors which rotate in static and dynamic balance under all operating conditions. The meters have no reciprocating parts and no metal to metal contact of the spiral surfaces of the rotors.

For additional information write Ralph N. Brodie Company, Inc., Lowell Street at 61st Street, Oakland, Calif., *referring to* WORLD OIL *item* 283.

284—Cable Tool Swivel Hook

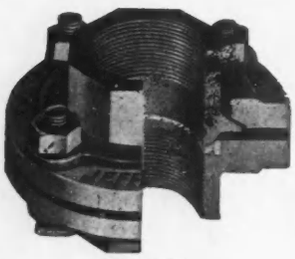
Short and compact in design, this cable tool swivel hook is 28 inches long from the center of clevis pin to hook. Capacity of the forged steel unit is 30 tons. It has ball bearing swivel.



Because of its small size, space is saved in handling pipe and casing. Wide center permits straight line pull from links to elevators and use of short elevator links. The unit can be adapted to any size blocks by changing swivel links. It has been field tested by use on cable tool rigs landing 13⅜-inch casing.

For additional information, write Superior Oil Tool Company, P. O. Box 423, Santa Fe Springs, Calif., *referring to* WORLD OIL *item* 284.

Jefferson Malleable Unions



STYLE "B"

JEFFERSON Style "B" three-piece flange union is made with brass-to-iron and iron-to-iron seats. Being made of highly refined AIR FURNACE iron. it assures you of lightweight construction, perfect ball joint, and positive seating arrangement, whether or not in alignment.

★ ★ ★

HYDRAULIC PRESSURE RATING

Sizes	Test Pres.	O. W. G.	S. W. P.-550 Deg.
½" thru 4"	2000#	800#	250#
5" and 6"	1200#	500#	250#
8" and 10"	1000#	400#	250#

Malleable iron used in all JEFFERSON unions meets ASTM 4733, Grade 35018—M. T. 53000 Lbs., giving 75% more elongation 50%-more impact value and is 30%-stronger than cupola malleable iron.

Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

71 Gooding St.,
Lockport, New York

31 Fletcher St.,
Lexington, Mass.

285—Trailer Mounted Generator

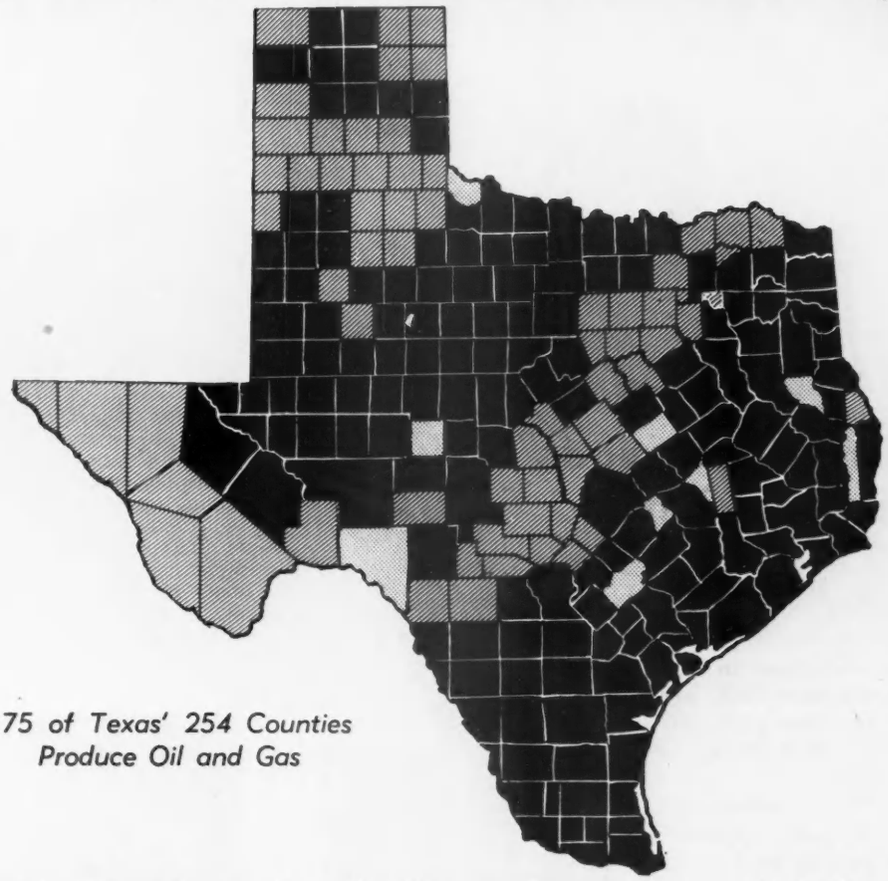
Fully equipped and self-contained trailer-mounted generator sets have capacities ranging from 10 to 85 kilowatts. The units are specially designed for on-the-job operation.

Available in both diesel and gasoline, 50 and 60 cycles, and in all standard

voltages, the sets consist of an engine driving a generator, with an instrument panel containing all starting controls and switchgear, spring-mounted on a pneumatic-tired four-wheel trailer.

For additional information, write International Diesel Electric Company, Inc., 13-02 44th Avenue, Long Island City 1, N. Y., *referring to* WORLD OIL *item* 285.

6 STATES...1% of the World's Land Area...
Produce *40% of the World's Oil!*



175 of Texas' 254 Counties Produce Oil and Gas

Second National of Houston is a Major Factor in Oil Financing in this Area

Texas possesses many great natural resources, but her Number 1 asset is Petroleum. Texas production is getting up toward the billion-barrel mark . . . was 902,875,000 bbls. in 1948. This was 44.7% of U. S. production . . . 26.6% of world production.

Houston is the focal point for oil activity in this Southwestern area . . . is one of the world's leading oil producing, refining and shipping centers.

As one of Texas' leading banks, The Second National Bank of Houston has long been a major factor in oil financing. Its Oil and Gas Division is directed and manned by practical oil men. Its attitude towards constructive projects is affirmative. Its policy is one of avoiding all unnecessary delay in the analysis of applications and the processing of loans.

Second National will welcome the opportunity of discussing with you the financial phases of any oil project in which you are or might be interested.

42 Years of Service to the Southwest

The **SECOND NATIONAL BANK OF HOUSTON**

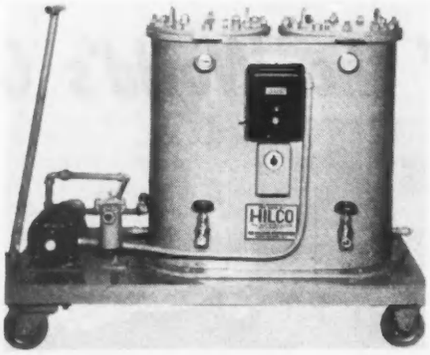
MAIN AT RUSK

CAPITAL AND SURPLUS TEN MILLION DOLLARS . . . MEMBER F. D. I. C.

286—Portable Oil Filter

Diesel engines and other equipment containing lubricating oil which requires periodic filtering can be serviced with the Hilco portable oil filter.

The unit consists of a filter assembly with or without electric heaters, and contains one or more filter cartridges. The cartridges can be packed with Hilite-fuller's earth for the filtration of straight run mineral oils, or Hiltex-cellulose for the filtration of heavy-duty or compounded oils. The entire unit is assembled on a base with ball-bearing casters, rubber-tired, and with a draw bar for moving the unit.



In operation, the one-fourth-horsepower motor driven pump withdraws oil from the equipment through a strainer which protects the pump. The oil is then delivered through the filter cartridge by means of pressure developed, and back into the oil system. Two lengths of oil-resisting hose are also supplied for convenience in connecting the filter to the lube oil system which is to be filtered. Dimensions of the unit are 24 x 36 x 36 inches. Capacity is from one-half to four gallons per minute.

For additional information, write The Hilliard Corporation, 102 West Fourth Street, Elmira, N. Y., *referring to* World Oil *item* 286.

PARAFFIN'S NO PROBLEM

when your sucker rods are equipped with

HUBER SCRAPERS

Paraffin can't accumulate in the tubing when your sucker rods are equipped with Huber Scrapers. NO PARAFFIN . . . NO TROUBLE . . . NO REMOVAL COSTS!

Huber Scrapers, shrink-fitted to new or used sucker rods, scrape paraffin from the tubing wall as the string rotates and reciprocates. This constant scraping prevents paraffin accumulation . . . eliminates paraffin removal.

Huber Scrapers quickly pay for themselves. Wells requiring paraffin removal every week or ten days have been on production for months without paraffin trouble after Huber Scrapers were installed.

If paraffin's a problem, install Huber Scrapers. Write for descriptive bulletin.

HUBER ROTATING ROD HANGER

This rod hanger rotates the rod string a fraction of a turn on each reciprocation. The horizontal teeth on the turn table are engaged by two ratchet levers which are actuated by a flexible steel cable attached to the walking beam. On each reciprocation the levers move the rod string a fraction of a turn.

SOLD THROUGH SUPPLY STORES

J. M. HUBER CORPORATION
P. O. BOX 831 BORGER, TEXAS

HUBER PARAFFIN SCRAPERS

SCRAPE AS THEY ROTATE AS THEY RECIPROCATE

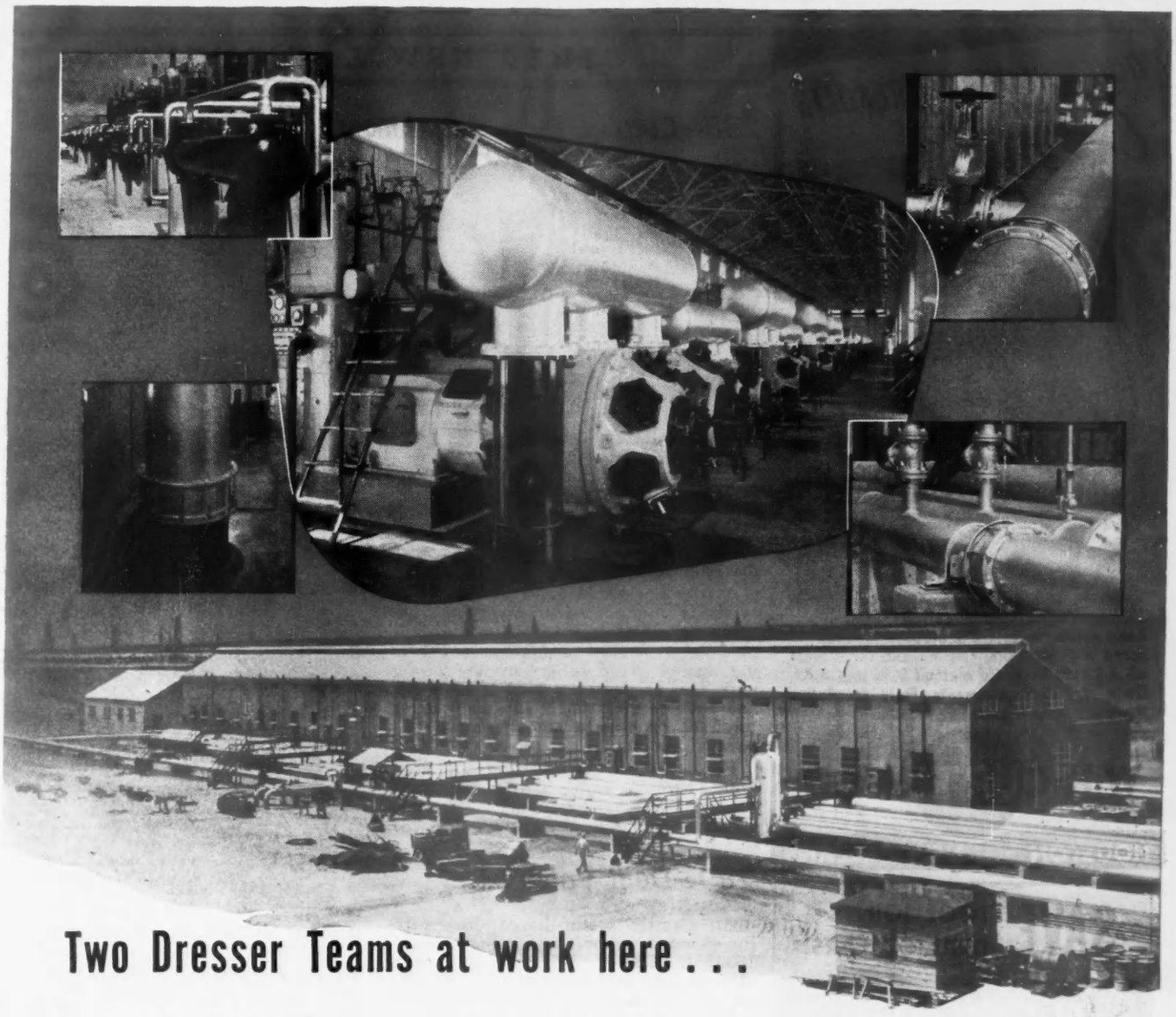
287—Pipe Saw

A new air-powered pipe saw that cuts cast iron or steel pipe from 12 to 48 inches in diameter at the rate of two inches per minute uses a high speed steel milling cutter which leaves clean cut milled edges and requires only 85 pounds of air pressure for operation. Changes in adjustment for different pipe sizes are made by setting guide rollers and altering the two travel-chain lengths.

The saw is strapped tight to the pipe by two silent type chains that act as a flexible ring gear for positive feed and automatically compensate for pipe "swells and irregularities." As it cuts, it travels around the pipe making the cut in one complete rotation. Weighing 265 pounds the saw can be handled and set up by two men in about 15 minutes.

Cuts above ground are made by rolling the pipe on skids while under ground cuts require only 14-inch clearance in the ditch. Sealed construction permits cuts to be made under water where ditches are flooded.

For additional information, write The E. H. Wachs Company, 1525 North Dayton Street, Chicago 22, *referring to* World Oil *item* 287.



Two Dresser Teams at work here . . .

Here are shots from the heart of one of the newest and most advanced natural gasoline plants in the country. The battery of compressors and the oil coolers were built by Clark Bros. Pipes to the jacket water reservoir, the jacket water cooler and pipe for fuel gas are coupled with vibration-absorbing, flexible couplings built by Dresser Manufacturing Div.

DRESSER INDUSTRIES is being called on to help engineer the most modern installations in the oil and gas industry because its ten subsidiaries have the highly specialized facilities of independent experts in their several fields. But through Dresser Industries, the engineering departments co-operate to achieve installations co-ordinated in equipment and over-all design. This produces the highest efficiency and greatest economy which is why the biggest jobs are going to Dresser.

Inquiries and requests for literature may be addressed to Dresser Industries, Inc., Terminal Tower, Cleveland 13, Ohio.

DRESSER INDUSTRIES INC.

TERMINAL TOWER • CLEVELAND 13, OHIO

THE ONLY COMPANY DOING AN OVER-ALL JOB } *from well to refinery for the Oil Industry— from source to consumer for the Gas Industry*

BOVAIRD & SEYFANG Manufacturing Company, Bradford, Pa. • **CLARK BROS.** Company, Inc., Olean, New York • **DRESSER** Manufacturing Division, Bradford, Pa. • **DRESSER** Manufacturing Company, Limited, Toronto, Ontario, Canada • **INTERNATIONAL** Derrick & Equipment Company, Beaumont & Dallas, Texas; Torrance, California; Columbus, Marietta & Delaware, Ohio • **KOBE,** Inc., Huntington Park, California • **PACIFIC PUMPS** Inc., Huntington Park, California • **ROOTS-CONNERSVILLE** Blower Corporation, Connersville, Indiana **SECURITY ENGINEERING** Co., Inc., Whittier, California • **STACEY BROS.** Gas Construction Company, Cincinnati, Ohio; **STACEY-DRESSER** Engineering Division, Cleveland, Ohio

QUICK, ACCURATE RESULTS
LESS EFFORT
Curtin CENTRIFUGES

No. 3420
15 c.c. machine . . .
Cranks and heads interchangeable with 100 c.c. machines.

Simple in design . . . Ruggedly built . . . Requires no special care . . . Great Ratio and throw of crank produce required speed with no strain. Curtin Centrifuges meet all *A.S.T.M. Standard Method D-96* and *A.P.I. Code No. 25* requirements. Fully descriptive literature upon request.

W·H·CURTIN & CO.

HOUSTON . . . NEW ORLEANS.

SAVE TOOL JOINTS DRILL COLLARS

Bill Womble's
ZINC COMPOUND

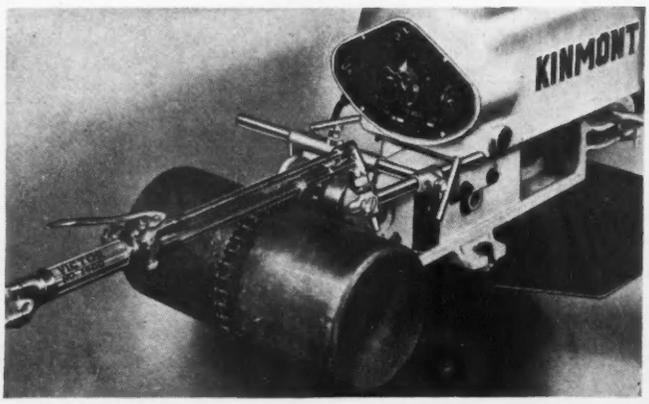
- Stops joint leakage, washouts and galling
- Prevents freezing of tool joints and drill collars
- Eliminates thread corrosion wherever threads are used! Proved in the lab and on the rig.

Ask for Bill Womble's Zinc Compound at your supply store or oil dealer . . . or write—

Bill Womble
404 Staley Bldg. Wichita Falls, Tex.
508A M & M Bldg. Houston 2, Tex.

OTHER NEW EQUIPMENT

288—Cutting Torch Attachment



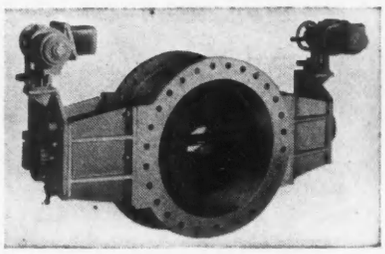
The principal features of a new cutting torch attachment, designed for use with the Kinmont Universal power unit, are its provision for adjustment of the cutting torch in handling a wide range of pipe sizes, and its ability to maintain a smooth bevel and a square cutoff across the end of the pipe.

The adjustment range of the attachment permits its use on any pipe size from three to 36 inches in diameter, and on tanks up to ten feet in diameter when turned on a roller rack.

A split link chain drive permits rapid fastening and unfastening of the work being turned. The drive chain holds the pipe tightly locked in position and turning against fixed rollers on the power unit. This prevents creeping of the work, and enables the attachment-held cutting torch to produce a smooth, accurately beveled and square pipe end.

For additional information write Kinmont Manufacturing Company, Inc., 716-718 West Wilson Avenue, Glendale, Calif., *referring to* WORLD OIL *item* 288.

289—Dual Valve



An electric motor-driven dual valve for elevated temperature will operate at 1000° F. The 36 x 8-inch, 150-pound, class B steel dual valve has a body casting of chrome-molly steel.

Powered by separate electric motors, each alloy steel vane is operated independently of the other to control volume and pressure. Designated Valve No. 725, it is designed for either a high pressure drop and small volume or a low pressure drop and large volume.

For additional information, write R-S Products Corporation, Wayne Junction, Philadelphia 44, *referring to* WORLD OIL *item* 289.

EXECUTIVE AIRPLANES

Douglas DC 3
Beechcraft Bonanza
Beechcraft Twin-Engine
Cessna
Navion
Lodestars

LOANS
Made to purchase any of the above new airplanes, used airplanes or on airplanes now owned. Terms from 12 months to 24 months.

LEASE RENTAL
Arrangements may be made to lease any model of new or used single-engine or twin-engine airplanes, with or without option to purchase.

FOR SALE OR LEASE
Any of the above named aircraft.

Note: Will consider in whole or part acceptable oil payments or royalty.

AIRCRAFT INVESTMENT CORPORATION
W. M. McDONALD, Vice-President
Municipal Airport FORT WORTH, TEXAS

A NEW IDEA

in PORTABLE PUMPING POWER

THIS mobile mainline pumping unit, owned and operated by Magnolia Petroleum Company, Dallas, sets a new standard of efficiency in portable pipe line pumps.

Powered by a General Motors Series 71 Diesel Quad 6, it has a capacity of 45,000 barrels of crude oil per day at 350 psi line pressure. Engineered to fit within road width, the entire unit weighs less than 30,000 pounds, including trailer.

Oil men everywhere find it pays to depend upon General Motors Diesels for their power requirements. These 2-cycle engines not only cut operating costs, but also provide fast, flexible power in space-saving, weight-saving units.

Let us show you how these modern Diesels can bring greater efficiency and economy to your particular job. Available in "Singles", "Twins" and "Quads"—43 to 520 continuous B. H. P. Write for illustrated folder, "A New Idea In Portable Pumping Power".

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES... *Up to 200 H.P.* **DETROIT 28, MICHIGAN** MULTIPLE UNITS... *Up to 800 H.P.*

GENERAL MOTORS

DIESEL BRAWN WITHOUT THE BULK

GM GENERAL MOTORS DIESEL POWER

GENERAL MOTORS CORP., DIESEL ENGINE SALES, PETROLEUM INDUSTRY, 1504 Philtower Bldg., TULSA 3, OKLAHOMA

Anderson-O'Brien Co. LOS ANGELES 21, CALIFORNIA
George Engine Co. NEW ORLEANS 18, LA.
Western Machinery & Engine Co. ST. LOUIS 10, MISSOURI
Diesel Power Co. OKLAHOMA CITY, OKLAHOMA
Empire Machinery Co., Ltd. ODESSA, TEXAS
West Coast Engine & Equip. Co. BERKELEY, CALIFORNIA
United Tool & Valve Repair Co. SHREVEPORT, LOUISIANA
Seitz Machinery Company Inc. BILLINGS, MONTANA
Stewart & Stevenson Services Inc. HOUSTON 11, TEXAS
Haynes Machinery Co. PLAINVIEW, TEXAS
Scranton Machine & Supply Co. GREAT BEND, KANSAS (Dealer)
Mountain Tractor Co. MISSOULA, MONTANA
Diesel Equipment Co. WICHITA, KANSAS

290—Alloy Steel Studs, Bolts, Nuts

A 48-page Catalog Handbook on heat treated alloy steel studs, bolts and nuts includes metallurgical data, specifications and prices. The booklet presents detailed information on the complete line of fastening and anchoring materials manufactured by and carried in stock by the company.

For a copy of this booklet write Texas Bolt and Supply Company, 2020 Commerce Street, Houston, *referring to* WORLD OIL *item* 290.

291—Spiral-Weld Pipe

Spiral-Weld pipe sizes and wall thicknesses are shown in a new bulletin which also lists fittings and flanges for use with the pipe. Typical applications are described.

For a copy of Bulletin 493, write Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, *referring to* WORLD OIL *item* 291.

UTILITY PLUS
CMC
The Sure Sign of Pump Dependability
"The little pump with a thousand uses" is how operators describe CMC DUAL PRIME Model 37 shown below circulating crude oil. For unmatched self-priming speed and the last word in simple, rugged and fool-proof construction always use CMC pumps. Available in sizes from 1½" to 10"—Capacities from 3,000 to 200,000 gal. per hour. Write for details.
CONSTRUCTION MACHINERY CO'S.
WATERLOO, IOWA
1903 BLODGETT ST., HOUSTON, TEXAS

292—Wire Rope Slings

Illustrations of actual installations of Hercules Flat-Laced wire rope slings feature Bulletin No. FLS-49. The slings, which were introduced early in 1948, are available for loads of various sizes, shapes and weights.

For a copy of this bulletin, write A. Leschen & Sons Rope Company, 5909 Kennerly Avenue, St. Louis 12, *referring to* WORLD OIL *item* 292.

293—Compressors

A two-page bulletin, F-2000, on single-stage and two-stage compressors gives detailed specifications, over-all dimensions and shipping weight. Lorain compressors are designed for operations on diesel oil, natural gas or butane.

For a copy of this bulletin, write White-Roth Machine Corporation, West 19th Street, Lorain, O., *referring to* WORLD OIL *item* 293.

294—Drilling Muds

A multi-colored 12-page catalog describes and illustrates drilling muds and mud service. Properties of each mud are given and its suggested applications noted. Mud testing instruments and test kits are also illustrated and described.

For a copy of this booklet, write Magnet Cove Barium Corporation, 5001 Richmond Road, Houston, *referring to* WORLD OIL *item* 294.

295—Flexible Couplings

Information on dimensions, horsepower ratings, stock and maximum bores is contained in a new 16-page catalog on flexible chain couplings.

For a copy of Catalog C45-49, write Morse Chain Company, 7601 Central, Detroit 8, Mich., *referring to* WORLD OIL *item* 295.

296—Pipe Fittings

A new two-color catalog contains a complete description of malleable iron pipe fittings, cast solder joint fittings and steel nipples, together with list prices and weights. Photographs of the products are included.

For a copy of Catalog 50, write Union Malleable Manufacturing Company, Ashland, O., *referring to* WORLD OIL *item* 296.

297—High Pressure Equipment

Drilling and production control equipment or deep, high pressure wells is discussed in a new 40-page, two-color book. Job photos, closeups, cutaway and cross-sectional drawings illustrate each product and its operational features. Capacity charts are provided where applicable.

For a copy of this catalog, write Oil Center Tool Company, 1912 Airline Drive, Houston, *referring to* WORLD OIL *item* 297.

Standardize on Standard

9 BIG STORES
CONVENIENTLY LOCATED

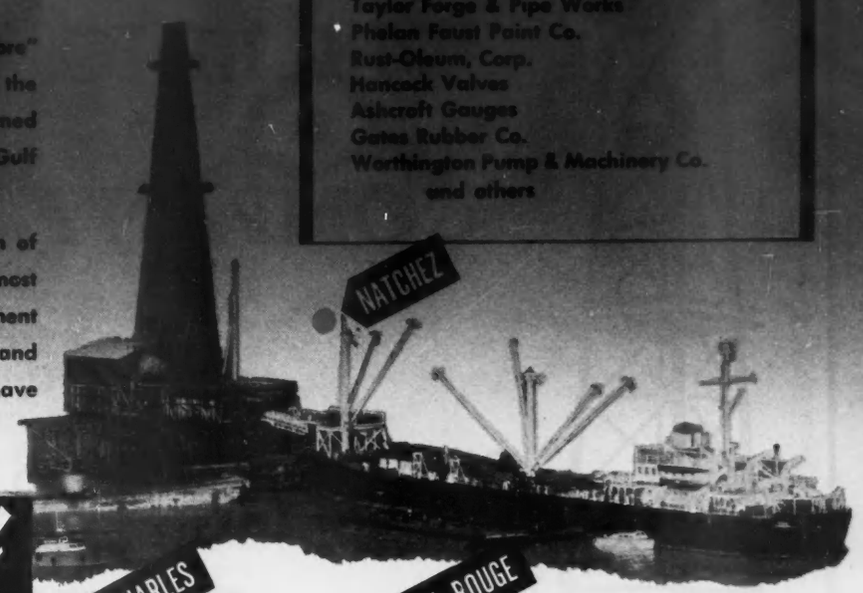
STANDARD pioneered in servicing the oil industry in the Gulf Coast. 9 big stores, completely stocked with the finest drilling and production equipment, are strategically located with respect to the active fields in this area . . .

Now comes the development of "off shore" Marine Drilling and you will find STANDARD on the ground, offering the same service that has earned the good will of operators throughout the entire Gulf Coast territory . . .

Houston has been selected as the location of our 9th branch store. Here you will find the most complete stock of drilling and production equipment and here you will receive the same co-operation and assistance in your production problems that have always characterized STANDARD service.

DISTRIBUTING THE PRODUCTS OF THESE LEADING MANUFACTURERS:

National Tube Co.
Republic Steel Corp.
Hughes Tool Co.
Reed Roller Bit Co.
Cameron Iron Works
Wickwire Spencer Steel Co.
Whitlock Cordage Co.
The Lunkenheimer Co.
Edward Valve & Mfg. Co.
Hewitt Rubber Corp.
Mission Mfg. Co.
Stockham Valves & Fittings, Inc.
Web Wilson Oil Tools
Link-Belt Co.
Nordstrom Valve Co.
National Transit Pump & Machine Co.
Taylor Forge & Pipe Works
Phelan Faust Paint Co.
Rust-Oleum, Corp.
Hancock Valves
Ashcroft Gauges
Gates Rubber Co.
Worthington Pump & Machinery Co.
and others



Standard

SUPPLY AND HARDWARE COMPANY
NEW ORLEANS, LOUISIANA

Branches — Lake Charles, New Iberia, Leeville, Houma, Harvey, Baton Rouge, La.; Natchez, Miss.; Houston, Tex.
Sales Office — 1317-18 Praetorian Bldg., Dallas, Texas.

298—Hydraulic Turbines

"Prevention and Reduction of Cavitation and Pitting in Hydraulic Turbines" is the subject of a new 12-page bulletin. Applicable basic formulas are elaborated upon and relative merits of avoiding cavitation or minimizing its effects are presented. Mechanisms of cavitation and pitting are explained in light of recent evidence.

For a copy of bulletin 02B7226, write Allis-Chalmers Manufacturing Company, South 70th Street, Milwaukee, Wis., *referring to* WORLD OIL *item* 298.

299—Pipe Protection

Current practices in pipe protection methods are described in the 22-page "Fifth Edition of the Book of Pipe Protection." Information is presented on coating and wrapping applications, cleaning, pre-heating, inspection methods, delivery scheduling, load unit shipping and field handling.

For a copy of this booklet, write Hill, Hubbell & Company, division of General Paint Corporation, 2627 Army Street, San Francisco, *referring to* WORLD OIL *item* 299.

300—Drilling Equipment

A general catalog consists of 60 pages covering drawworks, servicing hoists, portable masts, and cable tool rigs. Information is given on all current Cardwell models.

For a copy of Catalog 50, write Cardwell Manufacturing Company, Inc., P. O. Pox 2001, Wichita 1, Kansas, *referring to* WORLD OIL *item* 300.

301—Rubber and Asbestos

A new 16-page booklet describes rubber and asbestos products—such as rotary and other types hose, oil loading hose, belts for drilling and pumping, brake blocks and packings and gaskets—used in the petroleum industry.

For a copy of booklet 6903, write Manhattan Rubber division, Raybestos-Manhattan, Inc., Passaic, N. J., *referring to* WORLD OIL *item* 301.

302—Drilling Tools

A new three-color, 24-page booklet illustrates and describes core barrels and bits, drilling bits, milling tools, combination casing mills and cutters, whip stocks, water-cooled catheads, deviation recording instruments, key-seat wipers, rotary substitutes, wire line jars and check valves.

For a copy of this catalog, write A-1 Bit and Tool Company, 2000 Hussion Street, Houston 1, *referring to* WORLD OIL *item* 302.

303—Wellhead Assembly

A 24-page illustrated booklet entitled "20,000 Feet and Then Some" describes the wellhead assembly used on the world's deepest well. Engineering specifications and details of the O-C-T "C-19" casing head with recommended wellhead assemblies for deep, high pressure wells, are included.

For a copy of this booklet, write Oil Center Tool Company, 1912 Airline Drive, Houston, *referring to* WORLD OIL *item* 303.

304—Couplings, Fittings And Valves

The 28-page 1950 catalog of Unibolt couplings, fittings and valves for drilling, producing and pipelining is printed in three colors and is illustrated. It contains specification charts and drawings, and photographs depicting Unibolt's patented coupling principle.

For a copy of this catalog write Thornhill-Craver Company, Inc., Unibolt division, 1111 Lockwood Drive, Houston, *referring to* WORLD OIL *item* 304.

DAN L. CLARK W. M. AVERILL RUPERT COX

DAN L. CLARK DRILLING COMPANY

Drillers of OIL AND GAS WELLS

POWER AND STEAM RIGS

WILSON BUILDING
CORPUS CHRISTI, TEXAS

Telephones
Local 7746—7747 Long Distance 95

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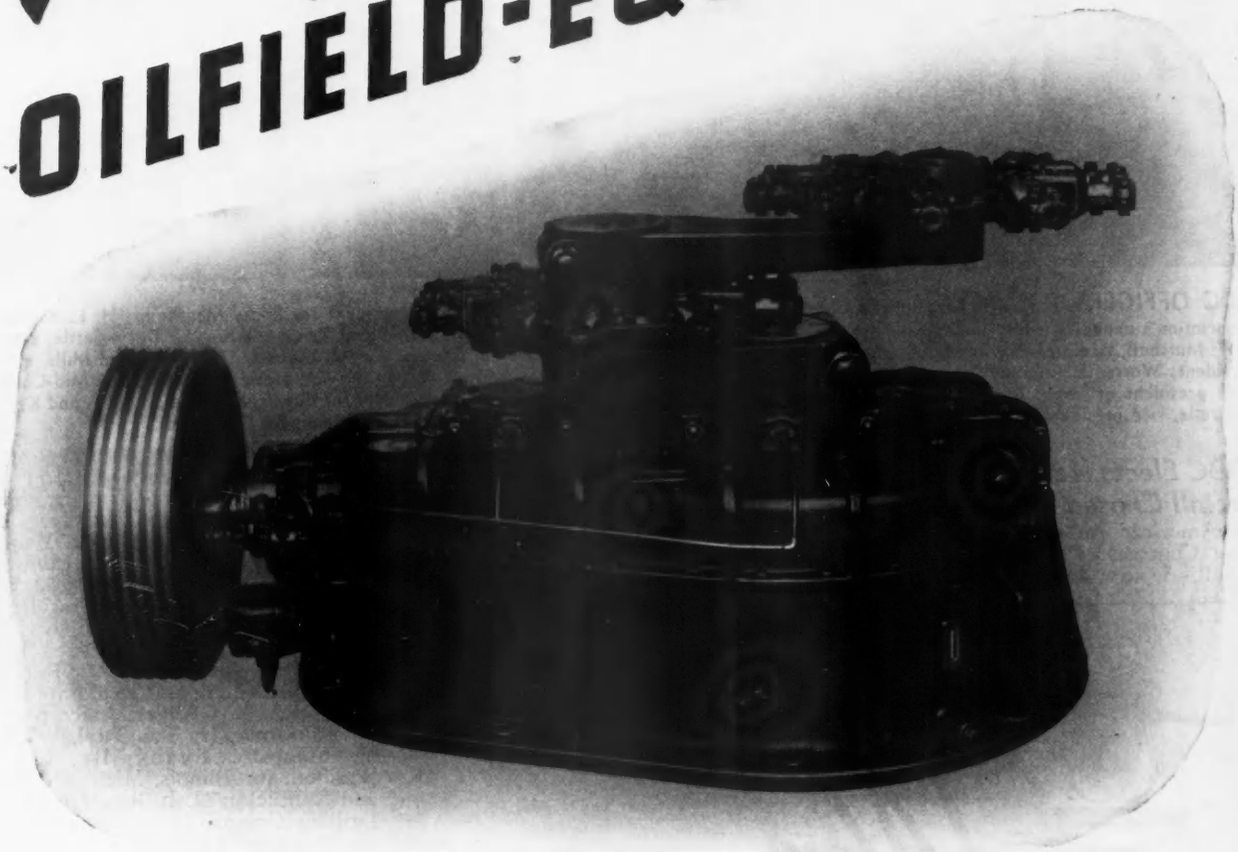
OILFIELD-EQUIPMENT



Bevel-Wheel—Helical-Wheel Gear Box for Central-Power, with dual crank for pull rods. Type TZ 100/2.

60 More than
Years experience in Mechanical Engineering
20 and more than
Years experience in the design and manufacture of Oilfield-Equipment gained in all oilfields of the world are embodied in our high quality products:

PUMPING UNITS • CENTRAL POWERS • SINGLE OR DOUBLE DRUM WINCHES • TELESCOPING MASTS • ROTARY POWER TRANSMISSIONS • CANTILEVER DRILLING MASTS WITH WUELFEL GEAR TYPE DRAW WORKS •

Please write for bulletin EW4487

EISENWERK WUELFEL · HANNOVER-WUELFEL · GERMANY

Associations

AAODC OFFICERS—New officers of the AAODC were elected at the Association's annual meeting in Dallas. First row, left to right, are Ralph W. Marshall, vice president for California; Joseph S. Morris, retiring president; Warren S. Churchill, incoming president; Joseph V. Dunbar, vice president at large; Louis A. Beecherl, treasurer. Second row, J. F. Postelle, vice president for West Texas and New Mexico; Zach K. Brinkerhoff, Jr., vice president for Rocky Mountains; H. L. Rowley, vice president for Cretaceous and Tertiary basins; J. Doyle Settle, secretary; and Marion S. Church, general counsel. Third row, Brad Mills, executive vice president; R. W. Wire, vice president for Central Mid-Continent; Ira Van Tuyl, vice president for Illinois, Michigan, Indiana and Kentucky; and Roger J. Wolfe, vice president for Gulf Coast.

AAODC Elects New Officers; Churchill Chosen President

The American Association of Oilwell Drilling Contractors elected Warren S. Churchill, Arrow Drilling Company, Dallas, president for the coming year at the three-day Ninth Annual Meeting in Dallas. More than 800 industry men attended the meeting.

Other new officers are Joseph V. Dunbar, Dunbar Drilling Company, Salem, Ill., vice president at large; J. F. Postelle, Postelle Drilling Company, Odessa, Texas, vice president for West Texas and New Mexico; J. A. Fox, Washington, Penn., vice president for cable tools; Roger J. Wolfe, Grey Wolf Drilling Company, Houston, vice president for Gulf Coast; R. W. Wire, Loffland Brothers Company, Tulsa, vice president for Central Mid-Continent; Ralph W. Marshall, Drilling and Exploration Company, Inc., Los Angeles, vice president for California; Ira Van Tuyl, V-T Drilling Company, Evansville, Ind., vice president for Illinois, Michigan, Indiana and Kentucky; H. L. Rowley, Big Chief Drilling Company—Mississippi, Shreveport, vice president for Cretaceous and Tertiary Basins; Zach K. Brinkerhoff, Jr., Brinkerhoff Drilling Company, Casper, Wyo., vice president for Rocky Mountains; J. J. Harrigan, Standard Well Service Company, Oklahoma City, vice president for well servicing; and Louis A. Beecherl, McDaniel & Beecherl Drilling Company, Dallas, treasurer.

Re-elected to the organization's staff at Dallas headquarters are Brad Mills, executive vice president; J. Doyle Settle, secretary; and Marion S. Church, general counsel.

Churchill worked for Roxana Oil Company as assistant general superintendent, and in 1926 became an independent operator and contractor. In 1928 he was invited to Moscow by the USSR for conferences on drilling at the time of the inception of the second Five Year Plan. He incorporated the Arrow Drilling Company in 1931, and is president of that firm. Churchill is one of the founders of the AAODC.

Fort Worth Geologists Elect

H. C. Vanderpool and W. Baxter Boyd have been elected president and vice president, respectively, of the Fort Worth Geological Society.

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★ **PERFORATE**
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● **TEST**
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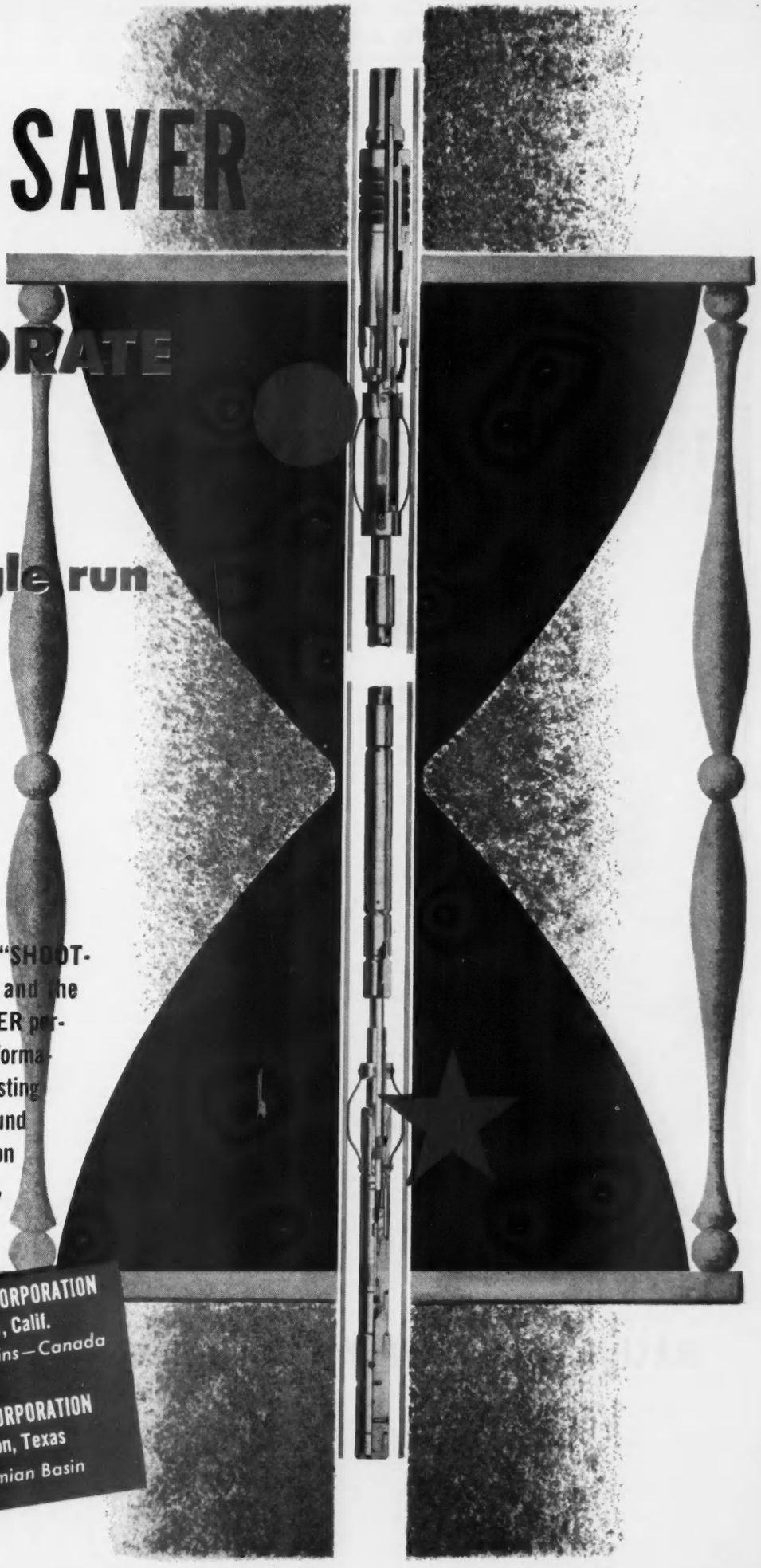

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API Program Will Carry Out "90 Years of Progress" Theme

With "Ninety Years of Progress" as the theme, the American Petroleum Institute will hold its 29th annual meeting in Chicago November 7-10. Approximately 5000 oil men from coast to coast are expected to attend the many group general and committee sessions.

The Stevens Hotel will be the site of all meetings except those of the Division of Transportation, which will be in the Palmer House.

Two general sessions will be held this year instead of the customary three. They will be Wednesday, November 9, with the first session starting at 2:30 p.m., and the second at 8 p.m. On the afternoon program are addresses by William E. Boyd, Jr., president of the API; Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana), and J. Howard Pew, a director and retired president of Sun Oil Company, Philadelphia. Presentation of the API Gold Metal for Distinguished Achievement will be made Wednesday afternoon.

The Wednesday night program will be highlighted by addresses by U. S. Senator Robert S. Kerr of Oklahoma; Admiral Louis E. Denfeld, Chief of Naval Operations and a member of the Joint Chiefs of Staff, Washington, D. C., and Edmund P. Learned, professor of business administration, Harvard Graduate School of Business Administration.

The Division of Transportation will hold a symposium on pipe lines in the Red Lacquer Room of the Palmer House at 10:45 a.m. Tuesday. J. H. Peper, The Buckeye Pipe Line Company, New York, will preside, and speakers will be J. W. deGroot, Tuscarora Oil Company, Ltd., Harrisburg, Penn., and Gordon N. Scott, consulting engineer, Los Angeles. Papers will be presented at the second meeting at 2 p.m. Tuesday by J. R. Mills, Jr., Standard Oil Company (Indiana), Chicago; F. T. Gardner and A. T. Clothier, The Carter Oil Company, Tulsa, and Francis Coryell, Interstate Oil Pipe Line Company, Tulsa; H. M. Shanahan, Continental Oil Company, Ponca City, Okla., and R. C. Nicholson, Shell Pipe Line Corporation, Houston; and J. E. Green, Shell Pipe Line, Houston.

The final group session of the Division of Transportation will be held at 10 a.m. Wednesday, with W. Alton Jones, Cities Service Company, New York, presiding. Speakers will include E. M. Webster, commissioner, Federal Communications Commission, Washington, D. C.; Charles L. Dearing, The Brookings Institution, Washington; and Thomas Pennington and James C. Posgate, Humble Oil & Refining Company, Houston.

Division of Production members will attend the first group session at 2 p.m. Tuesday, with R. O. Garrett, Arkansas Fuel Oil Company, Shreveport, presiding. Speakers will include B. L. Moore, Humble, Houston. H. H. Kaveler, Phillips Petroleum Company, Bartlesville, Okla., will preside at the second and final session at 9:30 a.m. Wednesday. R. L. Wheelock, vice president for production, will award API Certificates of Appreciation, and papers will be presented by G. B. Corless, Standard Oil Company (N. J.), New York; N. E. Tanner, Minister of Mines and Minerals, Edmonton, Alberta, Canada; and J. V. Pennington, Drilling Research, Inc., Houston. R. B. Anderson, Columbian Carbon Company, Charleston, W. Va., will report for the Division's Nominating Committee.

Santa Fe Streamliner Will Take Texans to API Meeting

Santa Fe's "API Special" will leave Houston at 6 p.m. November 5 and will arrive in Chicago at 7 p.m. November 6, for the API Convention November 7-10. The special streamliner will leave Chicago at 2 p.m. November 10 and return to Houston at 3 p.m. the following day.

The "Texas Chief," Santa Fe's daily streamliner between Houston and Chicago, leaves Houston at 8 a.m. and arrives in Chicago at 9 the next morning.

Geological Society Schedules Annual Meet November 10-12

The Geological Society of America will hold its Sixty-Second Annual Meeting in El Paso November 10-12, it was announced by Ronald K. DeFord, general chairman of the society.

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IS FAVORITE EVERYWHERE

For MUD and WATER Lines

- Quick, smooth, positive opening and closing
- Heavy screw prevents "kicking" against high pressures
- Seat is easily removable when necessary
- Adjustable top gland for placing handle in position

Why waste money on make-shifts or substitutes . . . when the Big Four release valve is proved in use . . . designed specifically for mud and water lines. You want a release valve that will ALWAYS open and close quickly . . . Big Four has a heavy, fast running screw that operates the stem . . . quickly, dependably, smoothly!

The seat is removable, easily replaceable. But replacement is not required often as the seat is made of abrasion resistant rubber . . . further protected against abrasion by the unique stem design. Usually cutting action on valve seats occurs when the valve is first opened and the plunger is leaving the seat . . . this critical period is eliminated in the Big Four Release Valve through "play" in the stem which permits the plunger to jump clear of the seat when the seal is first broken.

The top gland is adjustable so that the handle may be placed in position conveniently for quick and easy operation. AVAILABLE FOR IMMEDIATE DELIVERY. Made in 2" size only for 5000 p.s.i. working pressure.

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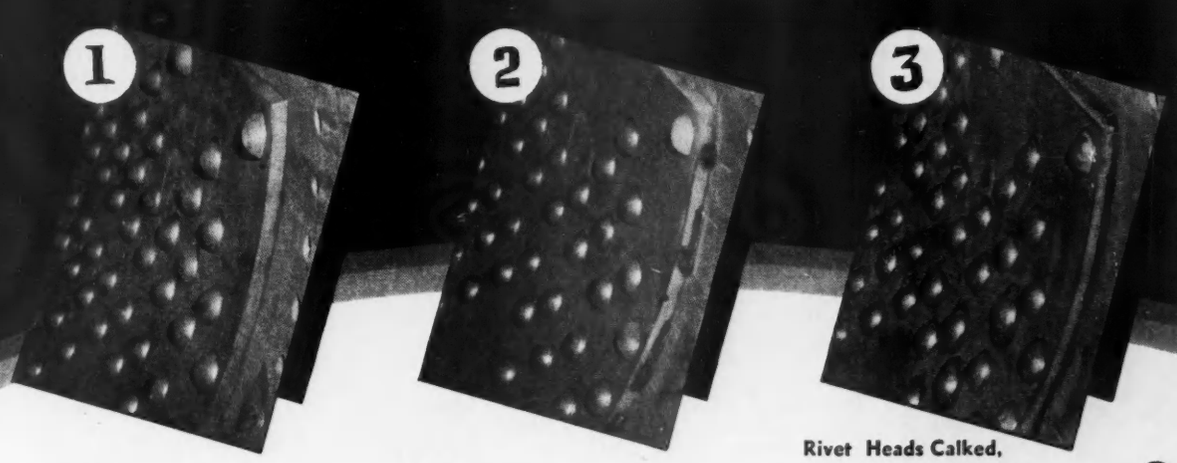

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Riveted, Spot-Welded and Peened Seam

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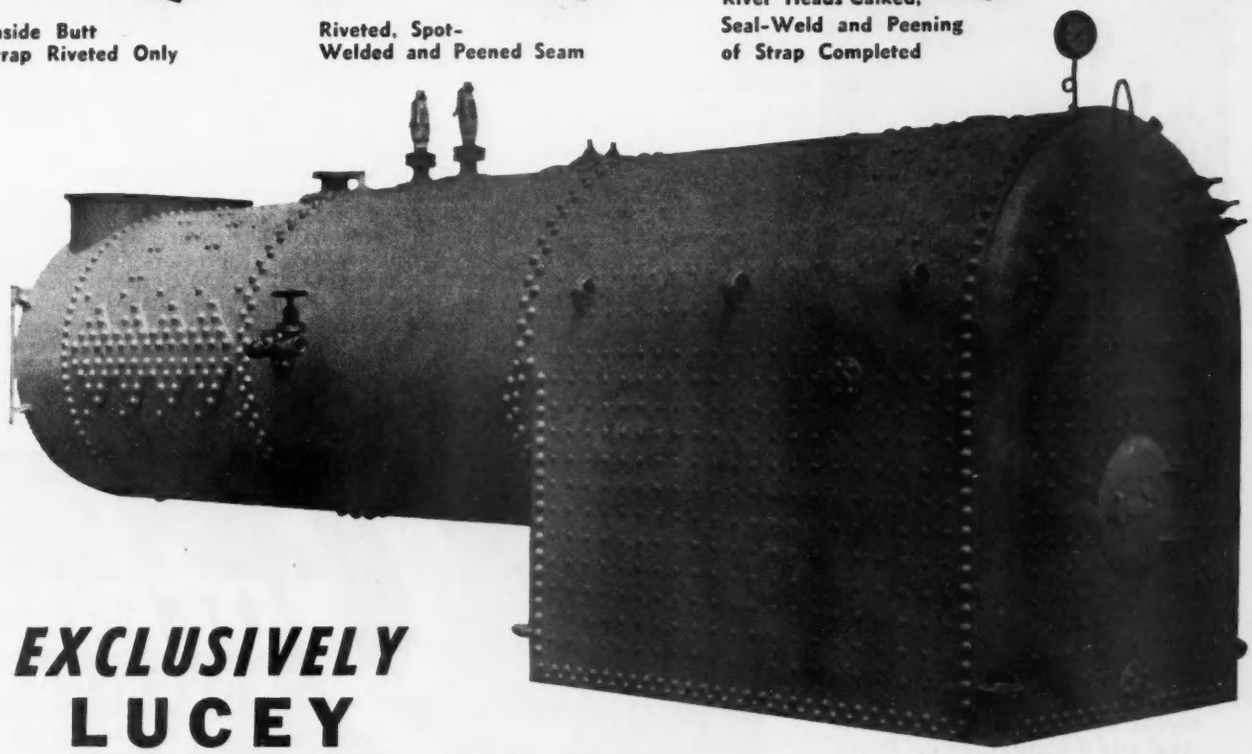

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Complete sealing-off of all possible joint leakage and seepage assures the highest in every-day performance. Double-Calked — inside and out — as well as Inside Seal Welding of the butt straps makes Lucey Oil Country Boilers the best for your money.

With the addition of these exclusive Lucey construction methods, coupled with many other exclusive Lucey features, Lucey continues to make "the best in boilers." The New Lucey Inside Seal-Welded and Double-Calked Boiler is now standard construction — and there is no increase in price.

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DARCOVA — THE ORIGINAL COMPOSITION CUP

ASSOCIATIONS

Independents Choose Warren As President of Association

J. Ed Warren, president of Carl B. King Drilling Company and a partner in King, Warren and Dye, independent oil producers of Midland, Texas, was elected president of the Independent Petroleum Association of America at the meeting in Fort Worth. He succeeds Fred W. Shield of San Antonio.

J. Ed Warren

New members of the executive committee, elected to serve three-year terms, are Clyde H. Alexander, Dallas; J. P. Coleman, Wichita Falls, Texas; Noble C. Ginther, Houston; Lawrence Vander Leck, Los Angeles; Robert L. Wood, Midland; and C. H. Lyons, Shreveport.

Warren received his BS degree in geology from the University of Washington in 1923. He then went to Wyoming, where his first job was as a roustabout and tool pusher with The Carter Oil Company at Salt Creek. In 1925, he was named a junior engineer with the U. S. Bureau of Mines at Denver, and in 1926 he joined Marland Oil Company at Albuquerque as geological scout. He transferred to Borger, Texas, in June, 1926, as a petroleum engineer in the Panhandle district, and later was assistant district superintendent of production with Marland and its successor, Continental Oil Company.

In 1934, Warren became associated with Carl B. King Drilling Company, a firm he now heads as president. King, Warren and Dye, another company with which he is associated, has its chief holdings in the West Texas area.

In addition to IPAA, Warren is a member of API, AAPG, AAODC, and AIME.

Texas Mid-Continent Group Chooses Leaders for 1950

Regional vice presidents elected by the Texas Mid-Continent Oil & Gas Association at the 30th Annual Meeting in Houston are E. L. Green, Jr., Cabot Carbon Company, Pampa, Panhandle; George Wagner Dimock, Akin & Dimock, Wichita Falls, North Texas; French M. Robertson, Abilene, West Central Texas; H. E. Chiles, Jr., The Western Company, Midland, Permian Basin; Raymond Dillard, J. K. Hughes Oil Company, Mexia, Central Texas; Watson W. Wise, Jackson, Wise & Snedden, Inc., Tyler, East Texas; W. C. Morris, Allen & Morris, San Antonio, Southwest Texas; John F. Lynch, La-Gloria Corporation, Corpus Christi, Lower Gulf Coast; Scott Myers, Unity Oil Company, Beaumont, Upper Gulf Coast.

R. B. Anderson, Vernon, was re-elected for a third term as president. Also re-elected were Andrew M. Howsley, Albany, general counsel; Charles E. Simons, Dallas, vice president and general manager; and Eugene McElvaney, Dallas, treasurer.

New directors include Harlan Ray, G. B. R. Oil Corporation, Dallas; H. B. Zachry, Francitas Gas Company, San Antonio; Roy Derrick, King, Warren & Dye, Midland; John Hurd, Killam & Hurd, Laredo; and V. F. Harrison, Southern Minerals Corporation, Corpus Christi.

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Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.)

Gotkool WATER CANS & COOLERS

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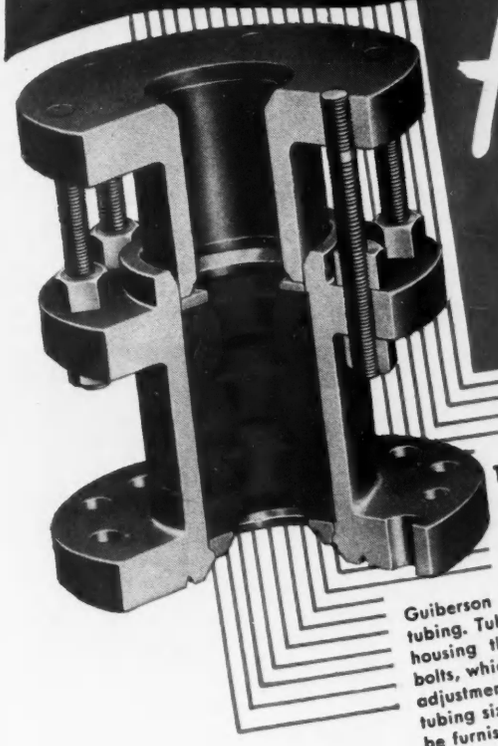
KEEP PURE DRINKING WATER ALWAYS HANDY

for heavy duty work at high Pressures

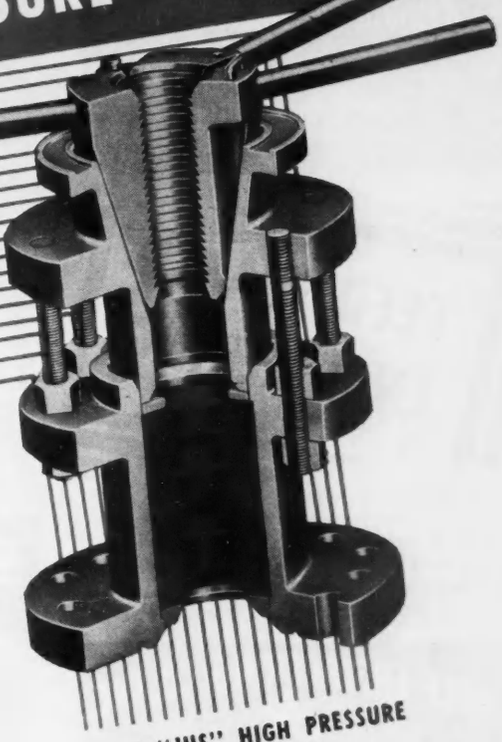
USE Guiberson "JU" and "JUS" HIGH PRESSURE STRIPPERS



TYPE "JU" HIGH PRESSURE STRIPPER

Compact with a minimum of parts. Flat top of packing gland enables operator to use standard Guiberson "B" Tubing Spider when running tubing. Tubing load is transmitted to stripper housing through six 1⅛" alloy steel stud bolts, which also serve as the packing rubber adjustment. The "JU" Stripper is made for tubing sizes of 1¼"*, 2", 2½" or 3" and can be furnished with 6" series 400, 600 and 900 or 8" series 400 bottom flange.

*1¼" rubber also packs off ¾", 1" and 1½" pipe, tubing and couplings.



TYPE "JUS" HIGH PRESSURE STRIPPER

With the same general construction as Type "JU", the "JUS" Stripper has a slip bowl made integral with the packing gland, providing a compact tubing spider arrangement with minimum overall height. Slip bowl made to receive Guiberson Type "B" Heavy Duty Tubing Spider Slips. Unique in design, the Guiberson unitized slips assure true fit in the bowl regardless of their vertical position and prevent sticking — they are extremely light, easy to handle and compact. The "JUS" Stripper comes with slip sizes of 1", 1¼", 1½", 2", 2½" or 3".

For running and pulling tubing under pressure, for clean-out work using reverse circulation, for any work where an inexpensive, dependable, non-rotating high pressure stripper is needed—Guiberson High Pressure Strippers are the ideal tools. Engineered for simplicity and speed in operation, Guiberson strippers come in two types, with or without slips. Specially designed accordion shaped packing rubber gives heavy duty service and a perfect seal-off around tubing under either low or high pressure. Pack-off rubber can be inserted or removed without dismantling stripper. Packing gland has 3" adjustment for different pipe sizes and taking up rubber wear. Tubing can be rotated and collars can easily pass through the rubber without leakage.

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Trading Post Ahead Page 356

ASSOCIATIONS

Petroleum Division AIME Elects Sherborne Chairman

New officers were elected by the Petroleum division AIME at the association's Fall Meeting in San Antonio. More than 900 members and guests attended the three-day session. John Sherborne, Union Oil Company of California, Los Angeles, was elected 1950 chairman, and Paul Andrews, Signal Oil & Gas Company, Los Angeles, and chairman of the Pacific chapter, was elected vice chairman of the Petroleum division. Also elected vice chairman was R. W. French, Sohio Petroleum Company, Cleveland, O. Two nominees for the executive committee elected were R. C. Earlougher, Earlougher Engineering Company, Tulsa, and John R. McMillan, Fullerton Oil Company, Los Angeles. Thirty-two technical papers were presented on drilling, cementing, pumping, natural gas technology, flooding, cycling, reservoir engineering, reservoir performance, well spacing, well logging, phase relationship, fluid flow research and core analysis.

John E. Sherborne

L. E. Young, president of AIME, gave an address on the influx of statism into our industries. L. F. McCollum, president, Continental Oil Company, gave a luncheon address on "Management's Challenge." Other addresses were made by A. L. Solliday, executive vice president, Stanolind Oil and Gas Company, and Carl Illig, assistant to the president, Humble Oil & Refining Company.

J. D. Cunningham Is Elected President of ASME for 1950

James D. Cunningham, president of Republic Flow Meters Company, Chicago, was elected national president of The American Society of Mechanical Engineers for 1950. In 1911 Cunningham founded and became president of the Steam Appliance Company, which is now Republic Flow Meters Company. He has previously held office as a manager and regional vice president of ASME and has served on many of its committees. He became a Fellow of the Society in 1936.

Jas. D. Cunningham

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Typical of the broad service utility of Wisconsin Air-Cooled Engines in oil field operations is this unique installation, pumping 9 oil wells in a northern Oklahoma field. A VP-4 (30 H.P.) Wisconsin Power Unit is connected to a beveled gear eccentric power drive, made by the Union Machine Co., of Bartlesville, Okla. . . . eliminating costly concrete foundations, building construction costs, etc., as well as eliminating worry about water supply tanks or radiators.

For heavy-duty service on any type of power application from 2 to 30 H.P., you can place your complete confidence in Wisconsin Air-Cooled Engines.

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It is well for the Petroleum Industry as a whole that problems of inventory can now be turned over to a sound and efficient Supply Industry whose sole function is to have on hand, conveniently located to petroleum operations, sufficient quantities of the proper equipment, of current design, at current prices, with sufficient experienced personnel eager to render every possible service.
Why not tap the vast reservoir of oil equipment now on hand through the Supply stores and so release operating capital and eliminate inventory losses? The many services, conveniences and savings offered by your Supply Store cost you nothing—why not buy all your needs ". . Through Your Supply Store?"
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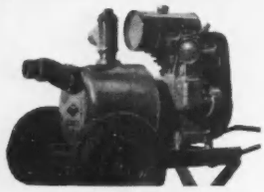
PUMPING PROBLEM?

Dependable service—day after day . . . for every pumping job in the oil fields . . . actually at lower cost! Designed and engineered to give you continuous heavy-duty performance—with "fuel-miser" economy and "zero" maintenance. That's the 52-year record of Carter Humdinger pumps.

Humdinger PUMPS



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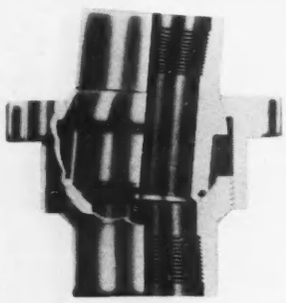
STRESS-FREE CONNECTIONS



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Mating members of the union move on two arcs of a true circle, assuring perfect seating and full contact of the O-Ring, sealing surface and retaining surfaces at all times. Because mechanical compression is not required, a certain amount of "swivel" is retained. Even at its greatest mis-aligning angle, there is no restriction of flow through the union.

Yale "Mis-Aligning" Unions are available in popular sizes through you supply store. Try one . . . and discover for yourself its many points of superiority.

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Men in the Industry NEWS

Earl B. Noble

Lon D. Cartwright

Lon D. Cartwright has been appointed chief geologist for all Union Oil Company operations, and will be responsible for correlation of all geological, geophysical and exploration activities of the various divisions, and will direct all activities outside assigned division areas. Cartwright, who has been with the company since 1939, was formerly chief geologist of the Gulf Coast division at Houston.

Earl B. Noble has been named general manager for Canada, and will be responsible for all exploration and development operations north of the International Line. He joined the company in

R. G. Greene

E. R. Atwill

1923 as a scout in the San Joaquin Valley and was most recently the company's manager of exploration.

R. G. Greene, formerly manager of lands, has been appointed manager of exploration, Pacific Coast.

E. R. Atwill is now manager of the Rocky Mountain division, with headquarters in Laramie, Wyo. He joined the company in 1926, and before assuming his new position was assistant chief geologist. Atwill succeeds **Max Krueger,** who resigned to become vice president in charge of exploration with the Conorada Petroleum Corporation in New York City.

L. N. Waterfall, chief geologist, Pacific Coast, resigned to enter geological consulting practice.

»

W. C. MacMillan has been elected executive vice president of Continental Oil Company. He was formerly vice president and administrative assistant to the president, and has been with the company more than 20 years.

Serge B. Jurenev, formerly secretary, was elected vice president in charge of coordinating and planning. He is succeeded as secretary by **Rawleigh Warner, Jr.,** previously assistant to the treasurer.

MacMillan, Jurenev, **R. L. Bosworth,** financial vice president; **A. W. Tarkington,** treasurer; **Thomas F. Dowd,** controller; and **Harry J. Kennedy,** vice president in charge of marketing, will transfer from Ponca City, Okla., to Houston early in 1950. Continental department heads who will move to Houston are **W. E. Webb,** manager Production department, and **John Post,** manager, Industrial Relations department.

»

H. S. M. Burns was elected a director and president of the newly-consolidated Shell Oil Company (formerly Shell Union Oil Corporation), and **Alexander Fraser,** former president, was elected chairman of the executive committee. **George Legh-Jones** continues as chairman of the board of directors. All vice presidents of the subsidiary company, Shell Oil Company, Inc., were elected to similar positions in the consolidated company. **P. E. Lakin,** vice president, was also elected a director and will continue as the company's senior representative on the Pacific Coast.

»

W. J. B. Dixon has been appointed assistant to vice president (foreign) and **H. D. Teeters** has been named assistant to vice president (domestic) in organization changes announced by The Texas Company.

Dixon was formerly an assistant treasurer, handling foreign financial matters. Teeters was also formerly an assistant treasurer handling domestic financial matters.

Also announced was the appointment of **Elihu Madison** as manager of Texaco's Economics department.

»

William H. Beekhuis has been elected a vice president of the Standard Oil Company of California. Beekhuis, an economic counselor and formerly assistant comptroller of the company, has acted as secretary of Standard's executive committee for the past six months.

His career with Standard has been largely as an economist and analyst, since his graduation from the University of California in 1930.

William H. Beekhuis

»

W. H. Barclay has been appointed assistant general superintendent of production for Midstates Oil Corporation, Tulsa. Barclay has been associated with Bovaird Supply Company, Marland Oil Company, Darby Petroleum Corporation, Darby and Bothwell, Inc., and Tide Water Associated Oil Company, during his 28 years experience in the oil industry.

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DEHYDRATING DESALTING

Lester M. Snyder

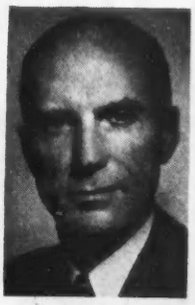
Lester M. Snyder has been elected vice president of the Arabian American Oil Company. Snyder began his oil career with Standard Oil Company of California in 1931. In 1939 he went to Saudi Arabia as chief field engineer for Aramco. After returning to the U. S. in 1947, Snyder served as assistant to the president.

Ken R. Burns, petroleum and geological engineer, has organized Ken R. Burns, Engineering and Producing Company, with offices at Wichita Falls, Texas, and Tulsa, to engage in exploration and exploitation work in the Mid-Continent and West Texas areas, and as consultant in engineering and technical problems.

»

David Dorn has been named manager of Forest Oil Corporation's new district office at Wichita Falls, Texas. **Eddie Hungiville** and **A. G. McCarver** will be landman and geologist, respectively.

Howard B. Nichols has been elected a director, a vice president and a member of the executive committee of California Texas Oil Company, Ltd., and as a director of The Bahrein Petroleum Company, Ltd., of which he is also a vice president and member of the executive committee. Nichols has been with the Caltex - Bahrein group of companies since January, 1938.



Howard B. Nichols

»

Dr. J. M. Hansell has been appointed geologist for the Canadian division of Sun Oil Company's Production department, with headquarters at Calgary, Alberta. Dr. Hansell was formerly at Dallas as regional geologist.

Deloss F. Drake, former motor products salesman, has been named land representative for Sun at Cleveland. **Clay Mullins** has been made district foreman at Sour Lake, Texas.

»

B. G. Martin, formerly Houston division geologist for Gulf Oil Corporation, has been appointed assistant to the vice president for producing operations. Martin has been with Gulf since 1928, except for two leaves of absence, one to continue his geological studies at the University of Oklahoma, and later, from January, 1942, to August, 1944, when he was employed by the PAW at Houston as production analyst and conservation engineer.

B. G. Martin

Martin is a member of the AAPG and the Houston Geological Society.

»

M. E. Daniels, Breckenridge, Texas, banker, and his associates have purchased controlling interest in the States Oil Corporation, Eastland, Texas. The company has holdings in Coleman and Eastland counties, Texas.

»

H. H. Arnold, division manager for The Texas Company at Denver, has been given additional duties as manager of exploration for Texaco Exploration Company and McColl-Frontenac Oil Company in Canada.

»

A. M. Blevens, formerly with C. W. Cotton Supply Company, has been named representative of Arrow Drilling Company at Tulsa.

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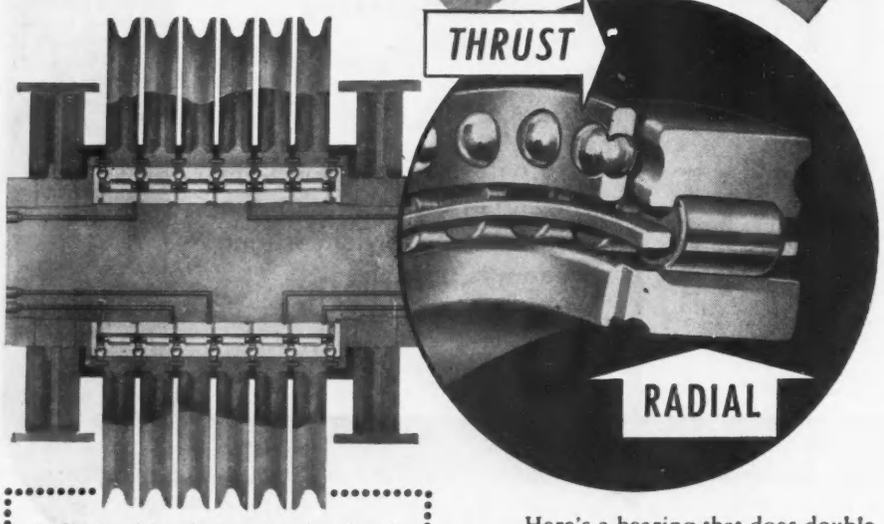

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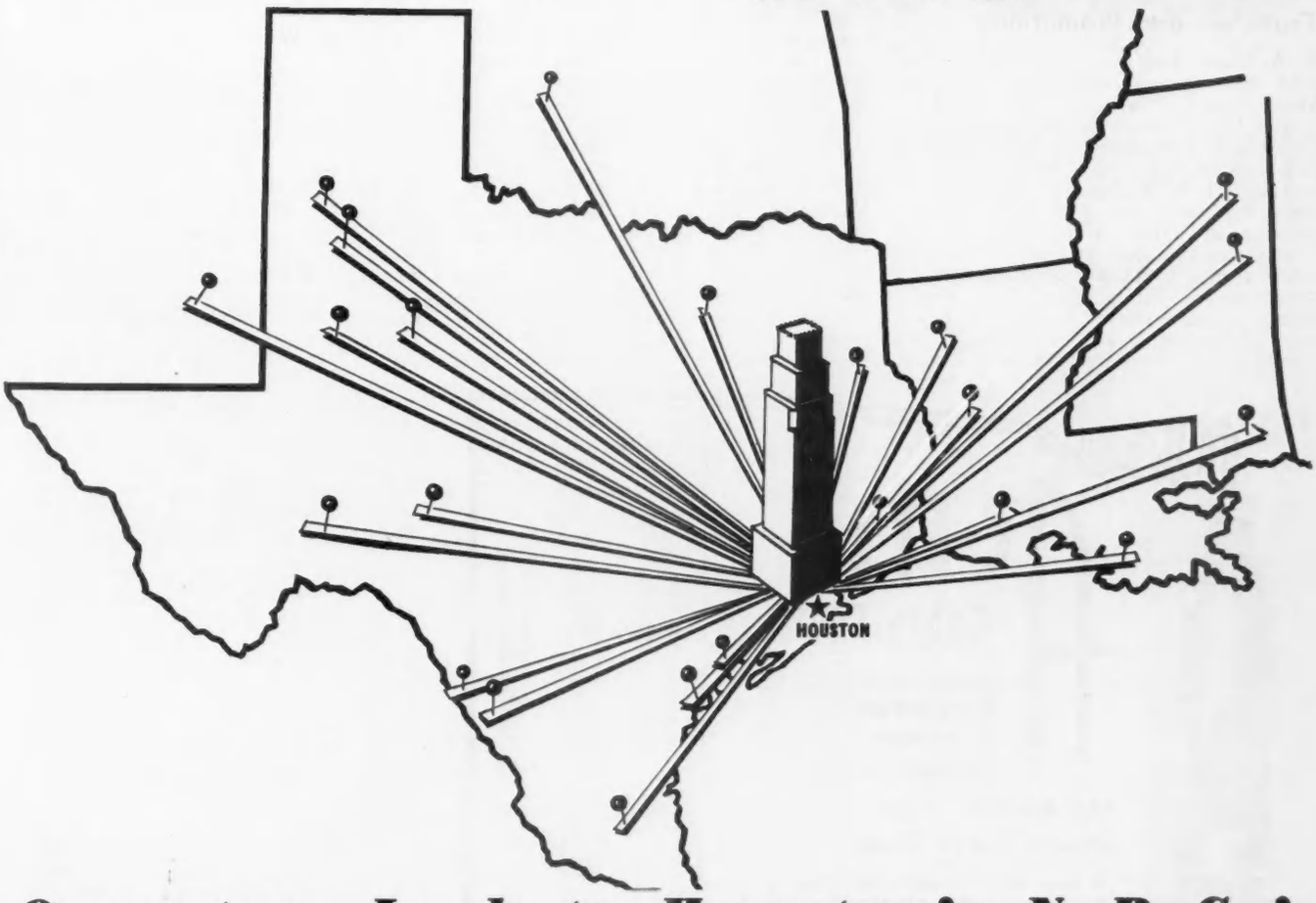

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Transfers and Promotions:

A. A. Hunzicker, formerly supervisor of field operations, Geophysical division, West Texas Producing division, The Texas Company, with offices in Fort Worth, has been transferred to Houston and promoted to assistant to division manager. **J. W. Sigley,** The Texas Company, has been assigned to the Land division at Tulsa from scout in the Evansville, Ind., area. Covering the Tri-State region is **Daniel Shanks,** former scout in the Enid, Okla., area. **Buell Neese** was transferred to Perry, Okla., from the scouting office in Tulsa. **L. B. Snedden** has been transferred to Los Angeles as assistant to division manager, Pacific Coast division, Producing department. He was formerly assistant manager of Texaco's Geophysical division in Houston . . . Changes announced by Cities Service Gas Company include assignment of **Rex Richardson** as superintendent of the Tallant station, Osage County, Oklahoma, to succeed **F. A. McAdams,** new head of the compressor station at Saginaw, Mich. **George W. Crane,** formerly at Saginaw, is now superintendent at Knobnoster, Mo. **Carol McCoy** succeeded **Harold Moore** as superintendent at North Hugoton compressor station, near Ulysses, Kansas. Moore is now superintendent at the Tonganoxie, Kansas, compressor station.

Carl W. Wilson, district engineer at Premont, Texas, for Sunray Oil Corporation, was transferred to Tulsa general offices in the gas engineering section. He was replaced by **J. Frank Dingee,** formerly district engineer, Oklahoma City. **Bob Parks,** engineer, San Antonio, moved to Tulsa in the reservoir engineering section. **G. D. Strother, Jr.,** Great Bend, Kansas, engineer, transferred to San Antonio in reservoir engineering. **Thomas M. Allen,** Tulsa office engineer, was assigned to Wewoka, Okla., as engineer, replacing **W. L. Gaither,** resigned. **Lee Pruitt,** division engineer, was made district superintendent for the Odessa district in Sunray's North and West Texas division. **M. S. Patton,** formerly Gulf Coast division engineer, Alice, Texas, transferred to the West Texas division, Midland. **Bill Yinger,** engineer, transferred from Oklahoma City to Midland. **Loyd L. Peek,** Forsan, Texas, transferred to Scurry County as district foreman. He was replaced in the Big Spring, Texas, district, by **Jay Newcomb** from the Odessa district. **A. J. Wise,** district foreman, Perry, Okla., moved to Comanche, Okla.

Philip H. Jennings was transferred from Houston where he was district geologist to Magnolia Petroleum Company's general offices in Dallas as staff geologist. **W. R. Canada** was promoted to district geologist in charge of the Houston-Lake Charles, La., district. **J. F. Mayfield,** formerly petroleum engineer in the Rusk, Texas, district, was transferred to the Rodessa, La., Producing district. **Joseph E. Dinger,** who has been assistant foreman in the Falfurrias district, has been promoted to production foreman at Lake Charles.

Sun Oil Company has appointed **W. H. Devine** to development geology in the Jameson, West Texas, area. **Sam Coggin** was transferred from Jameson to the geological department in Dallas; **W. L. Erwin,** from Tallahassee, Fla., to Jackson, Miss.; **James A. Alcorn,** from the Dallas office to surface work; and **Dr. Louis Jordan,** from Tallahassee to Amarillo to do paleontological work.

E. R. Fleshman, formerly with Phillips Petroleum Company at Muenster, Texas, has returned to Oklahoma City. **I. J. Pierce,** Evansville, Ind., district geologist, was transferred to Calgary, Alberta. . . . **J. R. Keeling,** landman for Lion Oil Company, has been transferred from Jackson, Miss., to division office in Denver. . . . **T. J. Skrabanek** was promoted to superintendent of Lone Star Gas Company compressor stations, succeeding **B. L. Rogers,** retired. . . . **Ralph L. Fields,** formerly with Shell Oil Company at Bogota, Colombia, was transferred to Oklahoma City. . . . **Charles B. Gillespie, Jr.,** Superior Oil Company geologist, was transferred from Shawnee, Okla., to Oklahoma City. . . . **M. D. Tucker,** geophysicist with Barnsdall Oil Company, was transferred from Casper, Wyo., to Calgary, Alberta. . . . **Jack L. Dunn,** former division production superintendent in the North Texas area with Warren Oil Corporation, is now manager of the Panhandle area, with offices at Kellerville, Texas. Dunn is succeeded by **Jack L. Coulson,** formerly assistant division production superintendent.

Paul L. Lyons, formerly technical

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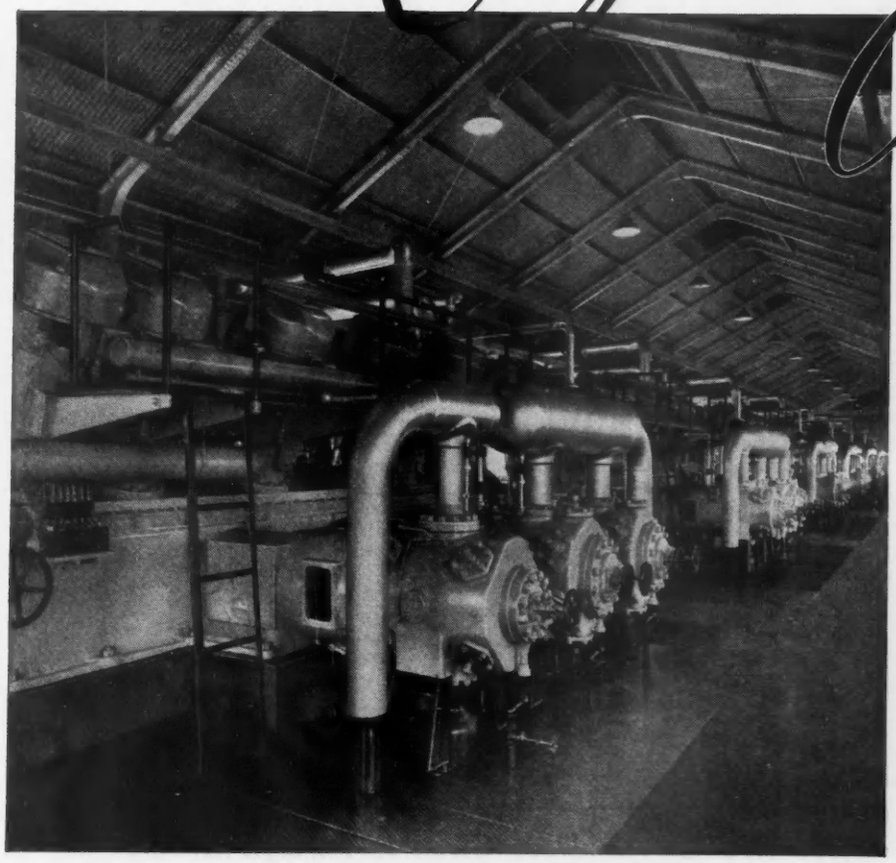

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MEN IN THE INDUSTRY NEWS

assistant in the Geophysical department of The Carter Oil Company, was promoted to technical assistant to **H. F. Moses,** vice president in charge of exploration and research. **H. W. Brown** has been advanced to assistant chief geophysicist, and replaced as supervisor of foreign geophysical operations by **R. F. Weichert,** who has been on loan to the Imperial Oil Company, Ltd., from Standard Oil Company (N.J.). **R. C. Clark,** formerly supervisor of geophysical operations in Carter's Northwest division, is new supervisor of foreign operations. **C. N. Hurry** is now supervisor of domestic geophysical operations.

F. H. Rhees, former division superintendent of Oklahoma, Wyoming and Montana, is now Sinclair Oil and Gas Company's general superintendent. **R. A. Wright,** formerly division superintendent at Casper, Wyo., is now in charge of the Producing division in West Texas-New Mexico, headquarters at Midland. **Floyd Brett** has been promoted from assistant division superintendent to division superintendent in charge of the Northeast Texas division, with headquarters at Fort Worth. **D. M. Engle** is division superintendent in charge of the Texas Gulf Coast division, headquarters in Corpus Christi, and has as assistant **T. C. Preston,** former district superintendent at Houston. **J. A. Jackman** has been advanced to assistant division superintendent in charge of the Wyoming-Montana division from district superintendent at Casper. . . .

Sohio Petroleum Company transferred **James P. Speer,** formerly with the company in Guatemala, to Oklahoma City as assistant supervisor of industrial relations in the Production department.

R. C. Granberry has been promoted to division petroleum engineer of Humble Oil & Refining Company's Southwest Texas division, Corpus Christi. **Sam Barclay, Jr.,** formerly supervising petroleum engineer in the Houston office, was transferred to the Southwest Texas division as assistant division petroleum engineer. Assistant division chief clerk **J. S. Moore** was transferred from the Avery Island district, Louisiana division, to the Goose Creek district, Gulf Coast division.

Spencer W. Pitts, assistant to the president of the J. M. Huber Corporation, has been elected secretary of the company by the board of directors.

Before joining Huber in 1945, Pitts was for four years assistant general counsel in the legal division of the War Production Board and, for three years prior, was assistant solicitor for the U. S. Department of Labor.

Spencer W. Pitts

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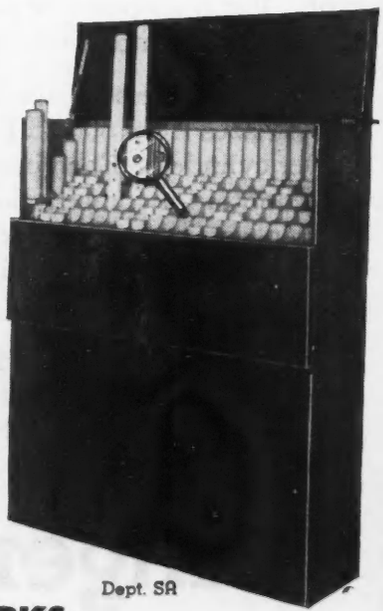

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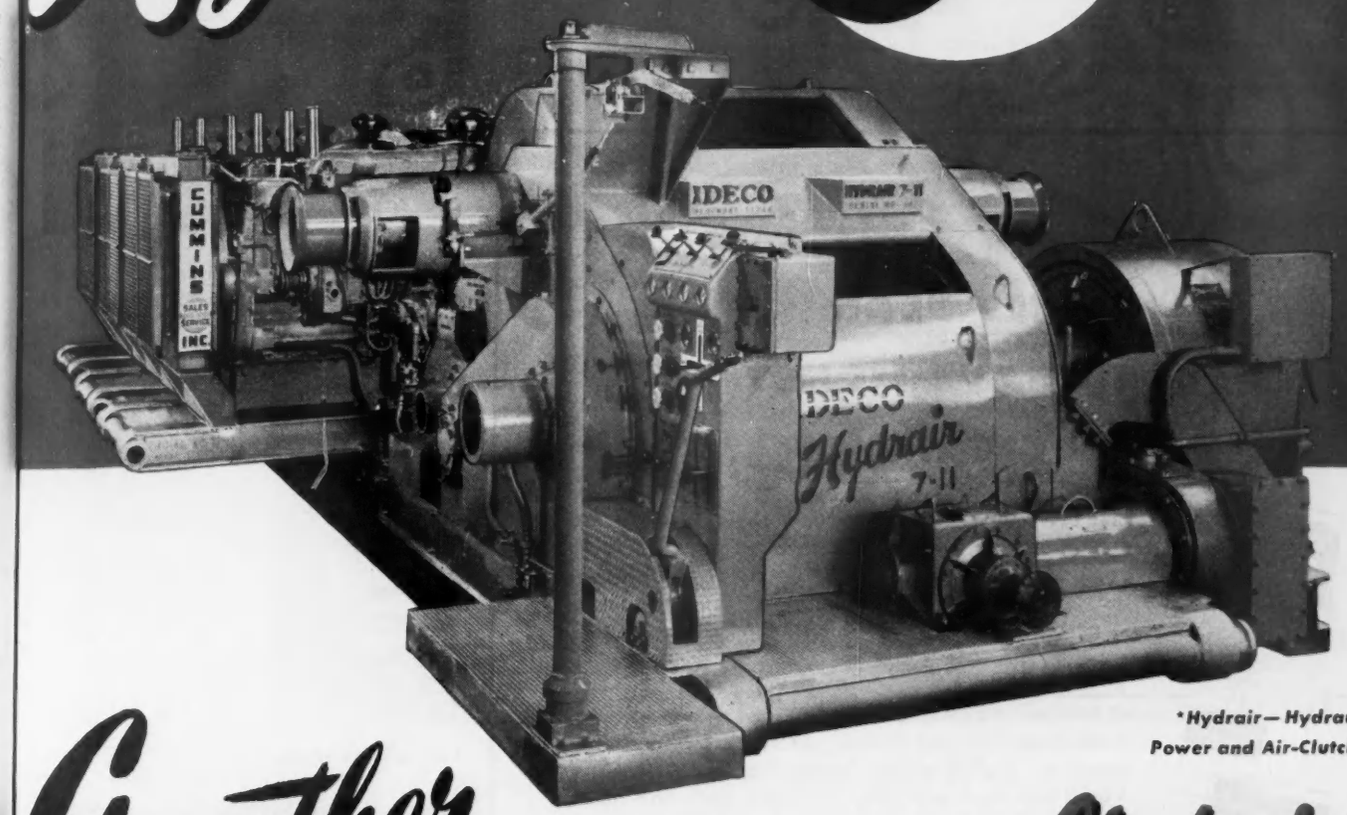

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Glenn Nelle has joined the General Petroleum Corporation as assistant manager of Rocky Mountain operations. Nelle will be at the company's Casper, Wyo., office and will report to **A. F. Barrett,** manager of Rocky Mountain operations. Nelle, a graduate of the University of Texas in petroleum engineering, has served in Venezuela with Socony-Vacuum Oil Company, Inc., since 1939.

»

R. Paul Henry has been appointed head of the income and excise tax department of Mid-Continent Oil Corporation, Tulsa.

C. D. Stephenson, chief geologist, has been elected vice president of Southern Production Company, Inc., and **Henry C. Calhoun** has been made manager of Land department.

Stephenson joined the company as chief geologist in 1947, after he had served with Southern Natural Gas Company, Jackson, Miss. He was previously a geologist with Shell Oil Company, and the Argentine government, and a consultant in Oklahoma and West Texas.

Calhoun was formerly assistant manager of Southrn Production's Land department. Formerly in the Land department of The Carter Oil Company, Calhoun joined the company in 1947.

»

Harold L. Kennedy, former Washington attorney for the Mid-Continent Oil and Gas Association, has joined the legal staff of The Ohio Oil Company. He will be associated with the Ohio's legal department in the Houston division and will be in charge of the Washington, D. C., office of the company.

Harold L. Kennedy

Kennedy was graduated from the University of Texas Law School and admitted to the Texas Bar in 1938. He was elected to the Texas House of Representatives in 1938 and re-elected in 1940 and 1942. He had been with the Mid-Continent Association since 1946.

»

Col. Luke W. Finlay, of the Law department of Standard Oil Company (N. J.), was ordered to active duty in the Army for six months to serve as executive officer of the Civilian Components Policy Board of the Department of Defense in Washington, D. C. The Board will promulgate and coordinate plans and policies of the reserve components of the armed forces.

Col. Luke W. Finlay

»

Horry F. Prioleau has rejoined Standard-Vacuum Oil Company as a director and vice president. Formerly senior vice president and a director of Creole Petroleum Corporation, Prioleau had been general manager of a Standard-Vacuum subsidiary in The Hague prior to the war.

Horry F. Prioleau

Associated with the petroleum industry in the U. S. and abroad since 1921, Prioleau went to The Hague in 1929 and became general manager there for Standard-Vacuum Petroleum Maatschappij in 1934. Forced out by the German occupation of Holland in 1940, he returned to the domestic oil industry and joined Creole in 1943 as assistant to the president. Prioleau was elected a vice president and director of that company in 1944.

»

Harold J. Kleen, has resigned as Oklahoma City district geologist for Skelly Oil Company, to accept a position as central division manager in charge of geological, land and scouting for Kerr-McGee Oil Industries, Inc., at Oklahoma City.

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DEATHS

Ray T. Moore, 55, Oklahoma and New Mexico independent operator, died September 29 in Oklahoma City. Moore went to Oklahoma in 1932 with Traffic Petroleum Company and later became an independent producer. At the time of his death he was connected with Ramco Corporation.

»

William C. Henning, president of A. Leschen & Sons Rope Company, St. Louis, died September 6.

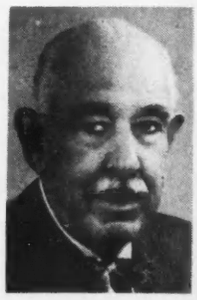
»

R. M. Sackett, assistant division superintendent of The Ohio Oil Company's Pipe Line department at Casper, Wyo., died September 9 in Casper. He was first employed by The Ohio in 1919.

J. E. Lassiter

J. E. Lassiter, 53, a director and general sales manager of Houston Oil Field Material Company, died September 25 in Houston. He had been with HOMCO since 1930, and rose from a branch manager to general sales manager in six years. In 1948 he was elected to the board of directors.

William Larimer Mellon, 81, a founder of Gulf Oil Corporation and its active head for 45 years, died October 8 in Pittsburgh. On May 26, 1948, Mellon retired as chairman of the board of Gulf, but he continued to serve as a director. Mellon began in the oil business in western Pennsylvania, where in 1889 he started drilling wells and shipping crude to market in tank cars. He later sold these interests, but again entered the petroleum field in 1901, with the Spindletop discovery in Texas. Gulf Oil Corporation was then organized to consolidate various oil interests, and Mellon was elected a director and vice president. In 1909 he was elected president, and in 1931 he became chairman of the board of directors and chairman of the executive committee.



W. L. Mellon

»

William T. Dinkins, 60, vice president and a director of Richfield Oil Corporation, died September 22 in Los Angeles. Dinkins had been with Richfield since 1937, and previously had been with Sinclair Oil Corporation.

»

William Walker, 76, president of the California Commercial Drilling Company, died in Los Angeles September 18. He had been president of the drilling company since 1925. Prior to that he was vice president and general manager of sales and marine department of General Petroleum Corporation.

»

Joseph D. Cotton, 75, vice president and director of The Four Wheel Drive Auto Company, died September 23 in Clintonville, Wis. Largest individual stockholder of the company, he had been connected with FWD since 1915. He was elected a member of the board of directors in 1918 and in 1919 became the first president of FWD's Canadian subsidiary. He was named vice president of the parent company in 1920.

Joseph D. Cotton

»

M. J. Munn, early-day Oklahoma oil man, whose geological studies brought the expansion of the Cushing field and the discovery of several others, died in Texarkana, Texas, October 2. Munn joined Gypsy Oil Company in 1918, leaving to help form Riverland Oil Company. He was known for his geological work with contour mapping, which he introduced to the U. S. Geological Service. He was also one of the first to contribute articles on geology to scientific journals. Before moving to Oklahoma in 1912 to be with Gypsy Oil Company, Munn had been with the U. S. Geological Survey.

Service Proves Value

Be Sure IT'S A KING *Be Safe*

KING SWIVELS 53-GA, 32-GA AND 20-GW

Types 32-GA, 53-GA and 20-GW swivels are alike in general design, but vary somewhat in detail.

These swivels have been field proven by several years of service and have been accepted as leaders in their class. They are in service throughout most of the oil world.

There are no other swivels which are comparable on a basis of capacity in proportion to weight.

Their high capacity in relation to their lightness make them ideal for use in remote and inaccessible places.

The 53-GA is used for drilling medium depth oil wells; also used extensively on work-over rigs. It is an ideal swivel for slim hole drilling.

The 32-GA is used with large water well rigs and for drilling relatively shallow oil wells. It is also used with long strings of tubing for washing down and similar operations.

The 20-GW swivel is used for drilling shallow and medium depth wells. The 20-GW is the smaller of the three and is used on water wells, core drilling rigs and the heavier types of Geophysical Rigs. It is also suitable for handling tubing in the shallower oil fields.

THE PRINCIPAL USES OF THESE SWIVELS ARE:

1. **Drilling shallow and medium depth oil wells.**
2. **Drilling water wells.**
3. **Core Drilling and Geophysical Drilling.**
4. **For slim hole drilling.**
5. **Working over oil wells.**
6. **Washing down pipe and tubing.**
7. **Running with inside pipe cutting tools.**
8. **Running with fishing tools.**
9. **As all purpose, lighweight swivels.**

All materials used in King Swivels are the best and most suitable for their purpose. Lubrication is provided and all connections are to API specifications or to the order of the customer.

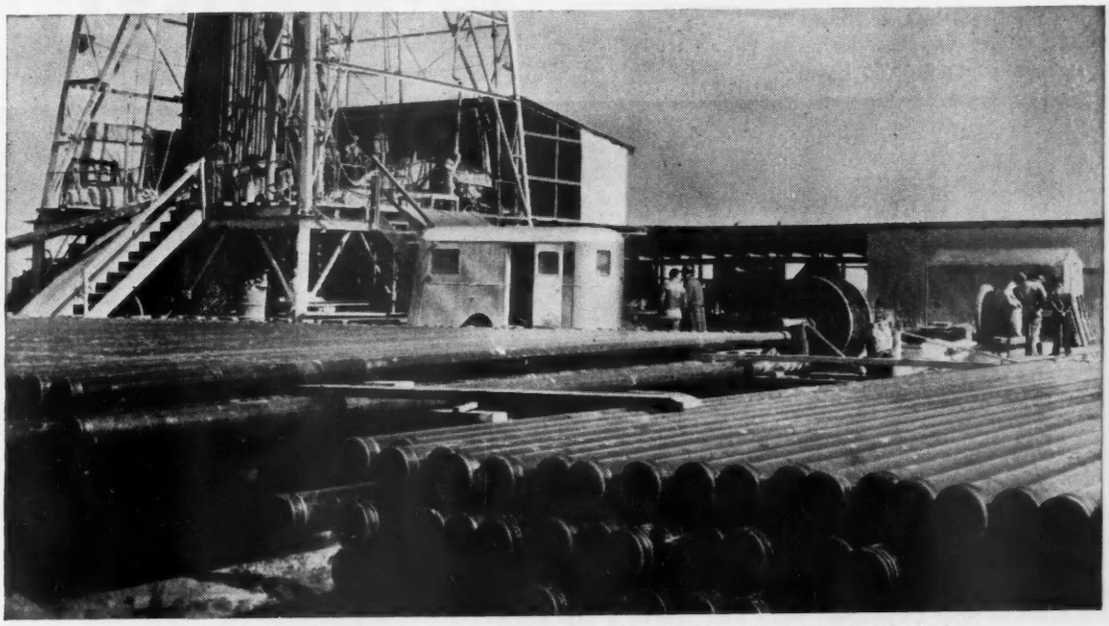
Order Through Your Supply Store

EXPORT: R. S. STOKVIS & SONS, INC.
17 BATTERY PLACE, NEW YORK 4, N. Y.

See Composite Catalog for detailed description of other King Tools.

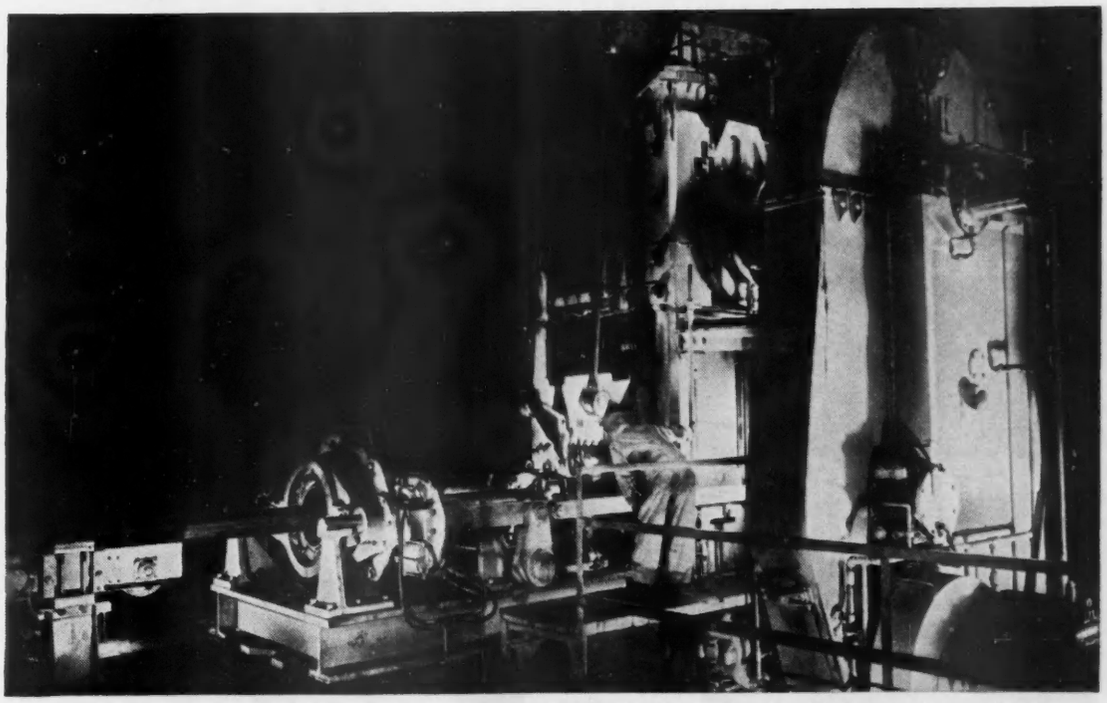
KING OIL TOOLS
210 TERMINAL STREET **PHONE WO-8013**
HOUSTON 20, TEXAS

DEPENDABILITY THROUGH



IN THE FIELD, LOUISIANA: Running a 10,000-ft. string of 8⅝-in. S-80 A. O. Smith Casing.

RESEARCH AND ENGINEERING



IN THE A. O. SMITH PIPE MILL: Research developed this special Smith-designed cold-compression machine for externally sizing A. O. Smith Casing.

A. O. Smith Corporation • New York 17 • Atlanta 3
Pittsburgh 19 • Chicago 4 • Houston 2 • Dallas 1
Seattle 1 • Tulsa 3 • Los Angeles 14 • International
Division: Milwaukee 1

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

NEW HOUSTON INDUSTRY LEADERS—A new Houston industry was announced by officials of A. O. Smith Corporation, Milwaukee, and Sheffield Steel Corporation, which have formed a new company, A. O. Smith Corporation of Texas, to manufacture welded pipe in Houston. At left, Warren S. Bellows, left, president of the Houston Chamber of Commerce, congratulates L. B. Smith, president of the new concern. Shown at right, left to right, are R. H. Startzell, sales manager of Sheffield Steel; D. F. McCarthy, manager, Tubular division, A. O. Smith Corporation, and vice president and general manager of A. O. Smith of Texas; John M. Floyd, director and vice president in charge of manufacturing of A. O. Smith Corporation, and vice president of the new company; and Hugh Wright, director of public relations of Armco Steel Corporation, parent company of Sheffield Steel.

$5 Million Houston Plant to Make Pipe for Oil and Gas Industry

A $5 million mill to manufacture large-diameter pipe for the oil and gas industry, second largest of its kind in the world, will be built in Houston.

The mill will be built and operated by a new firm, the A. O. Smith Corporation of Texas. Half of its stock will be held by the Sheffield Steel Corporation, and the other half by A. O. Smith Corporation of Milwaukee.

Construction is to be completed by the summer of 1950. The plant will have a capacity of from 30,000 to 35,000 tons of pipe per month, and will make pipe in 40-foot lengths ranging in diameter from 8⅝ to 30 inches or larger.

W. C. Heath of Milwaukee, president of A. O. Smith; Charles R. Hook of Middletown, Ohio, chairman of the board of Armco Steel Corporation; and R. L. Gray, Sheffield president, made the announcement in a joint statement. Sheffield is a wholly-owned subsidiary of Armco.

The new mill will provide for the first time a main source of oil and gas pipe in the heart of the Southwestern petroleum area, where most large diameter line pipe and oil and gas well casing are used. In the past this pipe was shipped from distant plants.

The new mill will be on Industrial Road in the Green's Bayou area near the Houston Ship Channel, near the present plant of A. O. Smith and the tide water plant of Sheffield, where iron ore, coal and limestone are made into pig iron, then steel and then into finished and semi-finished products.

Officers of A. O. Smith Corporation of Texas, which will own and operate the new mill:

A. Von Wenning, chairman of the board; L. B. Smith, president; John M. Floyd, vice president; D. F. McCarthy, vice president and general manager, and M. J. Vollmer, secretary and treasurer. All are officials of the A. O. Smith Corporation of Milwaukee.

Directors will include Gray, J. C. Shepherd, who is executive vice president of Sheffield; L. H. Juengling, Sheffield secretary; F. Ray McFarland, Sheffield Houston Division manager; Mr. Smith; Mr. Von Wenning; Rae F. Bell, who is A. O. Smith board chairman, and Heath.

every job a MASTER CEMENTING JOB

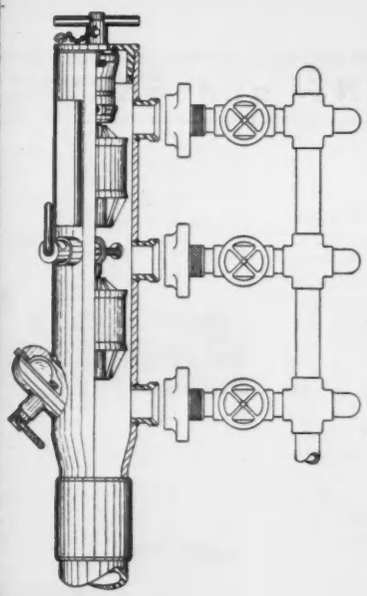
You never have to worry about results when you use the Rector Fulbore Cementing Method. Properly conditioned cement is confined between two piston-like plugs as it travels down the cementing string. It is the same uncontaminated quality when reaching bottom as when pumped in.

Full casing-bore discharge of the cement reduces discharge pressure without decreasing the volume . . . further prevents contamination and eliminates channeling.

You are sure the desired volume of properly conditioned cement reaches and stays behind the pipe. The back pressure valve which latches and locks in the stall collar, placed in the cementing string the desired distance off bottom, positively prevents any back flow . . . controls the amount of cement left in the casing.

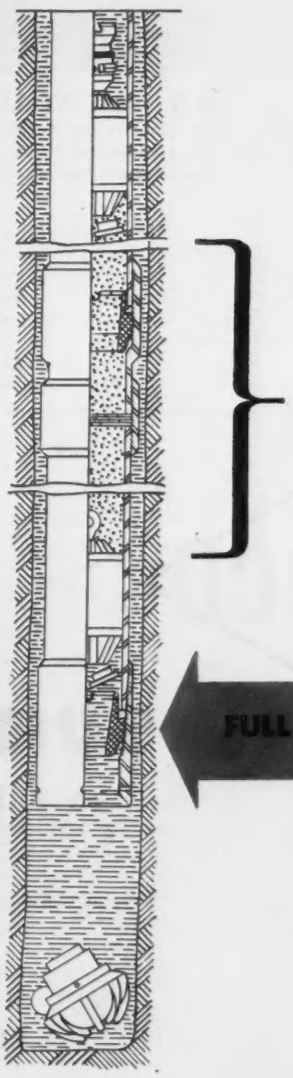
Don't take chances. Make sure your next cementing job is a Master Job, by specifying the Rector Fulbore Cementing Method. Ask your nearest Rector or Spartan Tool and Service Co. representative.

RECTOR WELL EQUIPMENT CO., INC.



MULTIPLE INLET HEAD

Three inlets assure ample capacity to pump in maximum volumes of cement as rapidly as desired. The Rector Cement Head provides a closed circuit and assures positive shut-in control throughout cementing operations. It is completely assembled with the two plugs and trip ball before making up on casing string . . . and is never opened after cementing operations begin. Positive means are provided on the head for releasing trip ball, which ejects float shoe assembly, and the two plugs with practically no shutdown time.



COMPLETE, POSITIVE CEMENT SEGREGATION

The two plugs used with the Rector "Fulbore" Cementing Method have a piston-like fit in the casing string to completely and positively segregate the cement, thus preventing any possibility of contamination. These tightly fitting plugs swab and clean the inside of the casing, both ahead of and behind the cement. You are sure properly conditioned cement reaches the bottom of the hole.

FULL CASING BORE DISCHARGE

By ejecting the entire float assembly from the Rector "Fulbore" Float shoe, the discharge area of the shoe is the same as that of the casing. This unrestricted opening reduces the load on the pumps by permitting the same volume to be circulated at lower discharge pressure. The uncontaminated cement enters the hole annulus at full casing discharge pressure.

RECTOR FULBORE CEMENTING METHOD

ASK YOUR SUPPLY STORE FOR RECTOR "FULBORE" CEMENTING EQUIPMENT

Lane-Wells Expands Facilities; Adds New Service Installations

Lane-Wells Company is nearing completion of an extensive program of expanding and improving plant and branch location buildings in six states. This program, including new construction and improvements on existing facilities, involves 26 locations.

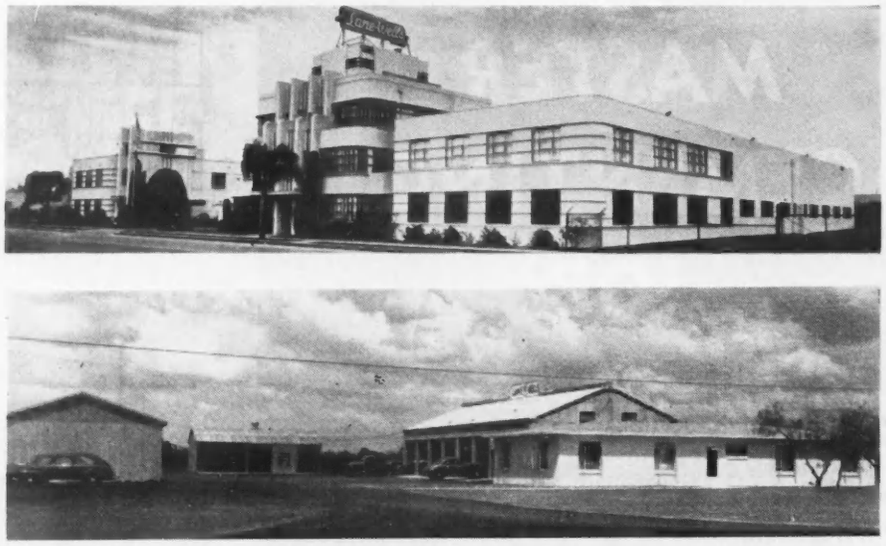
Two new factory buildings with a total floor space of more than 23,000 square feet have been added to the company's main plant in Los Angeles. One, a machine shop, was built adjoining the existing machine shop facilities to increase the production of packers and bridging plugs as well as guns and other equipment manufactured for use in the company's service operations. The second building is a new 12,000-square-foot truck and paint shop.

The Pacific Coast division headquarters, formerly located with the company's head office in Los Angeles, has been moved to new installations in Paramount, Calif. Special purpose buildings have been built for truck maintenance, storing and handling explosives, administrative offices, and stock storage.

New or improved branch office and shop buildings have been built at Bakersfield and Ventura, Calif.; Alice, Victoria, Odessa, Lubbock, San Angelo, Colorado City, Athens, Beaumont, and Jacksboro in Texas; Hobbs, N. M.; Magnolia, Ark.; Lake Charles, New Iberia, and Harvey, La.; and Healdton, Lindsay, and Oklahoma City, Okla.

At most locations the new installations include separate, specially engineered loading and storage facilities for Kone-shot charges, guns and equipment. These installations are designed particularly for safe and efficient handling of the high explosives used in this new service.

Additional construction is under way on company locations in Oklahoma City; Pampa, Texas; Cody and Casper, Wyo.; Great Bend, Kansas; and Edmonton, Alberta, Canada.



NEW LANE-WELLS INSTALLATIONS—(Top) New addition to the Lane-Wells Company plant in Los Angeles is the machine shop building on the right. Second floor of the building houses additional office space and new conference and board of directors meeting rooms. (Bottom) Typical of the type of installation used in the new branch locations is this district office and shop at Alice, Texas.

Baker Transfers Engineer

Baker Oil Tools, Inc., announced the transfer of Roger C. Finley, service engineer, from Tyler to Oklahoma City.

SUNOCO

SUN OIL COMPANY
an entirely independent unit of the petroleum industry

•

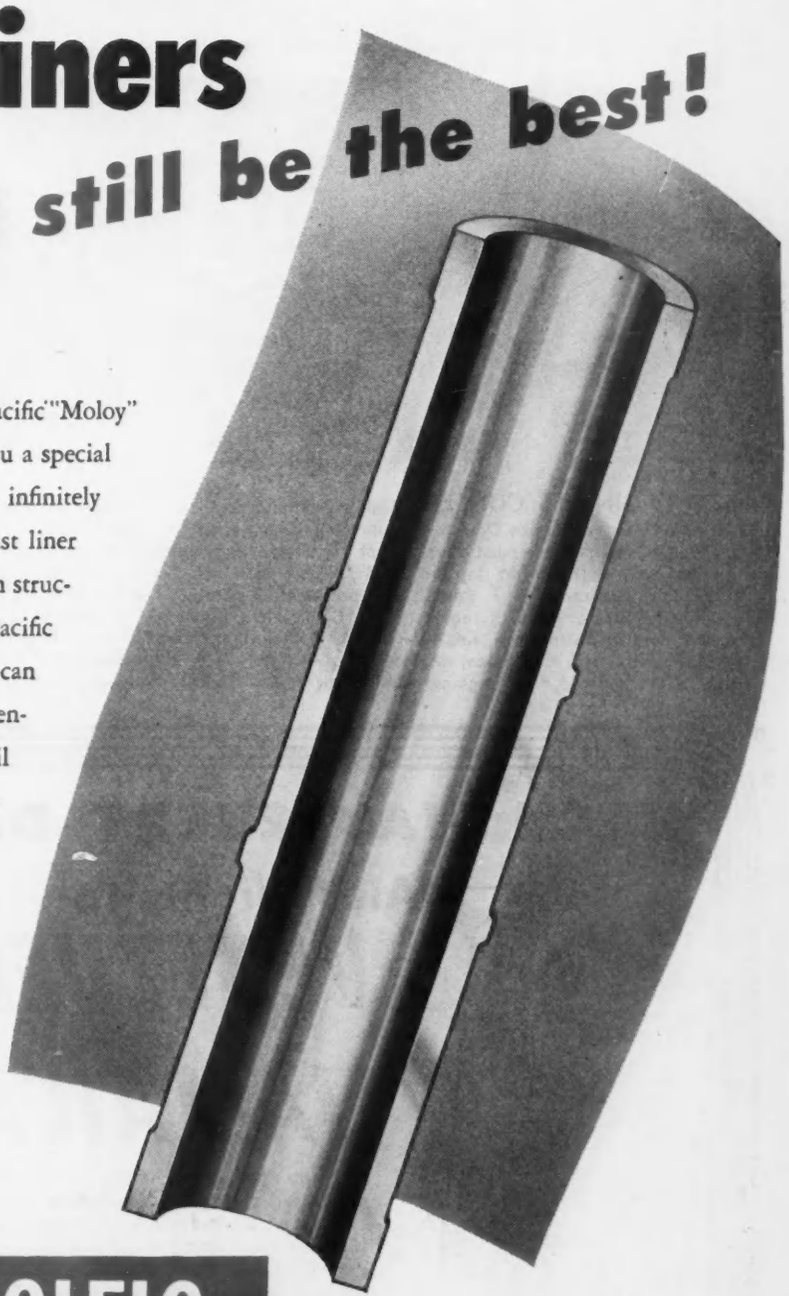
Manufacturers of
SUNOCO DYNAFUEL
SUNOCO MOTOR OIL
SUN INDUSTRIAL PRODUCTS
and a
COMPLETE LINE OF BLENDING OILS, FINISHED OILS AND GREASES

•

SUN OIL COMPANY
Philadelphia, Pa.

Texas Sales Offices:
DALLAS and BEAUMONT

by any other name . . . pacific "moloy" liners would still be the best!



Call them what you will . . . the superiority of Pacific "Moloy" Liners is unequaled. Only Pacific gives you a special "Moloy" molybdenum-alloy liner with infinitely greater resistance to wear . . . an electrical cast liner of especially high quality and uniform grain structure. Superior machining and materials for Pacific "Moloy" Liners cost us 30% more but you can buy them for the price of a conventional centrifugal cast liner. Pacific revolutionized the oil plunger pump industry more than 17 years ago with the introduction of Pacific "Moloy" Liners. Today the new Pacific "Moloy" Liners are vastly improved through constant research and field testing . . . today only Pacific "Moloy" Liners will give you the service and economy you demand.

PACIFIC PUMPS 25th ANNIVERSARY

Pacific Pumps inc.
ONE OF THE DRESSER INDUSTRIES

PACIFIC
Precision Built
PUMPS

HUNTINGTON PARK, CALIF.
Mid-Continent Division:
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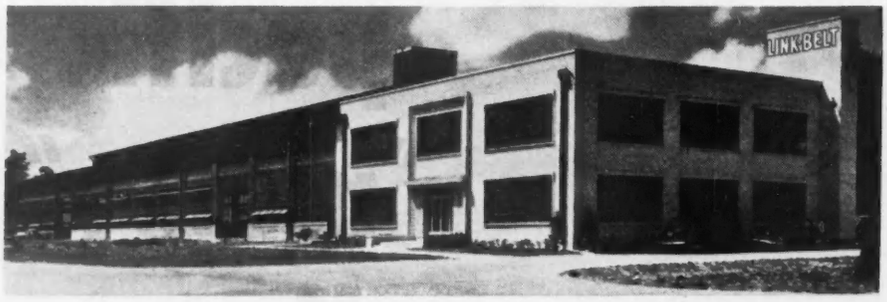
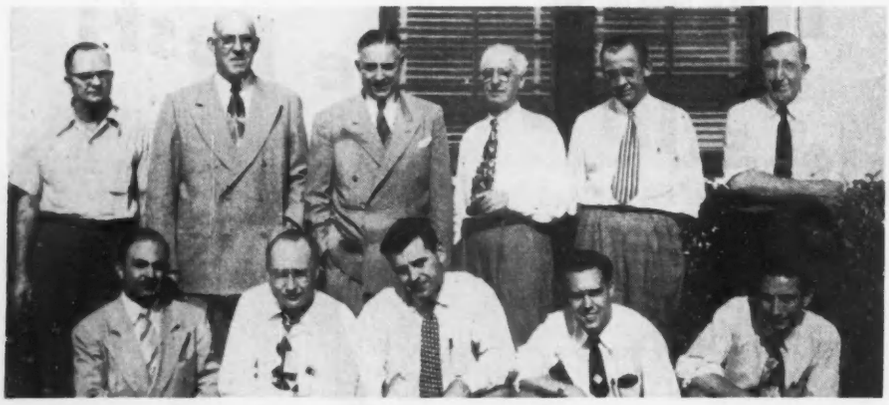
Export Office:
Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities

DW-2

LINK-BELT HOUSTON PLANT— Manufacturing operations have begun at Link-Belt Company's Houston plant at 3203 South Wayside. The plant comprises approximately 45,000 square feet of floor space, and contains a one-story, all-steel factory building with three bays, and a two-story office section of masonry construction. Allan Craig is general manager of the company's Southwestern division, with headquarters at the new Houston plant.





EMSCO ENGINEERS CONFER—Design and field engineers, representing the Los Angeles and Houston plants of Emsco Derrick & Equipment Company and the Dallas office of The Continental Supply Company, attended a meeting of key engineering personnel at Los Angeles. Attending the meeting were, left to right, top row, J. M. Corbett, assistant chief mechanical engineer; S. W. Webster, sales engineer; W. T. Powell, vice president in charge of production and engineering; G. R. Tremolada, chief research engineer; A. J. Olson, chief engineer, Continental; G. W. Whitney, chief metallurgist. Bottom row, left to right, A. A. Ashton, chief mechanical engineer, Houston; Leroy Newcomb, chief mechanical engineer, Los Angeles; D. A. Carnahan, chief engineer, D+B division; A. B. Fredhold, field engineer, California; and E. M. Cole, field engineer, Mid-Continent.

EACH WAY-EVERY DAY

—DAILY Flights to—

VENEZUELA and JAMAICA!

Chicago & Southern Air Lines' fleet of 4-motored Douglas Skymasters now offers seven-days-a-week service through the Houston and New Orleans gateways to Caracas and Kingston. Flights each way every day provide one-plane service from the Great Lakes to the Venezuelan oil capital. Ask your travel agent or nearest C&S ticket office.

CHICAGO & SOUTHERN AIR LINES

General Offices, Memphis, Tenn., U.S.A.

C★S

Kerotest Manufacturing Elects Frame, Isaacks Vice Presidents

William Frame and J. D. Isaacks, of Kerotest Manufacturing Company have been elected vice presidents. Isaacks has been named vice president in charge of steel valve sales, and Frame will serve in his former capacity of works manager in addition to his duties as vice president.

Frame joined Kerotest recently as works manager after having been associated with The National Supply Company for 14 years as works manager of its Spang Chalfant plant at Ambridge, Penn. Isaacks was formerly district manager for Kerotest in Houston.

L. B. Richardson Is Appointed Brown Oil Tools Service Manager

L. B. Richardson, who has been with Brown Oil Tools, Inc., for the past nine years, has been appointed service manager. For the past four years, Richardson has been manager of the company's Louisiana division with headquarters in Lake Charles. In his new position he will be in charge of all the company's field services, including fishing operations, pipe testing, packer setting, casing patching and other specialized services.

L. B. Richardson

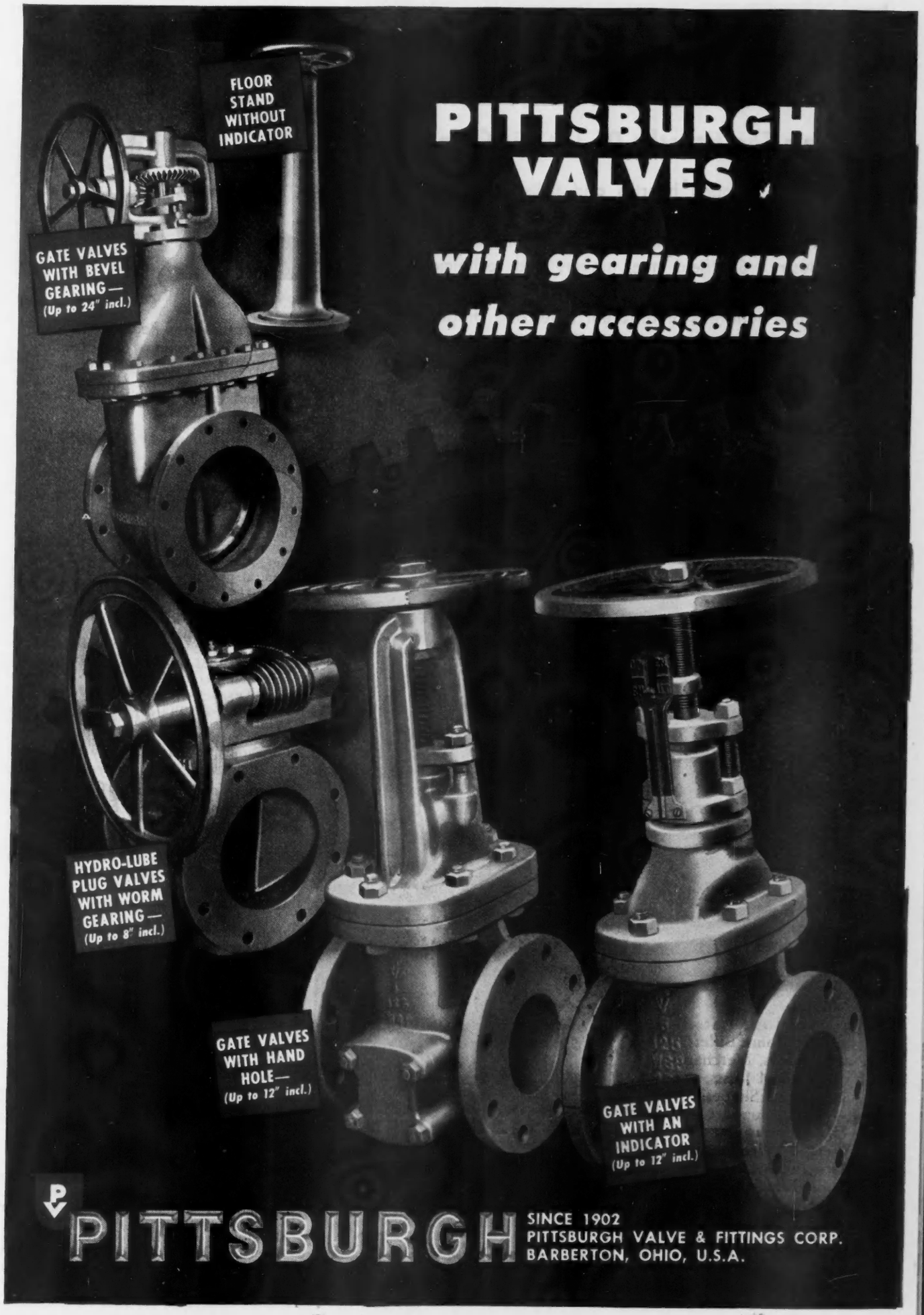
Adel Precision Products Appoints Miller and Stumm Vice Presidents

Fred T. Miller and R. A. Stumm, Jr., have been elected vice presidents of Adel Precision Products Corporation, Burbank, Calif., and Huntington, W. Va. Miller, formerly general sales manager, is vice president in charge of engineering and sales at Burbank, and Stumm, previously assistant to the president, is vice president in charge of manufacturing of the Burbank division.

Miller has been with Adel eight years. Stumm joined the corporation in December, 1946 as purchasing agent.

Moore Joins Daniel Staff

J. Virgil Moore has joined the Sales Engineering department of Daniel Orifice Fitting Company in Houston. Moore was formerly vice president and general manager of State Engineering Company, Inc., Houston.

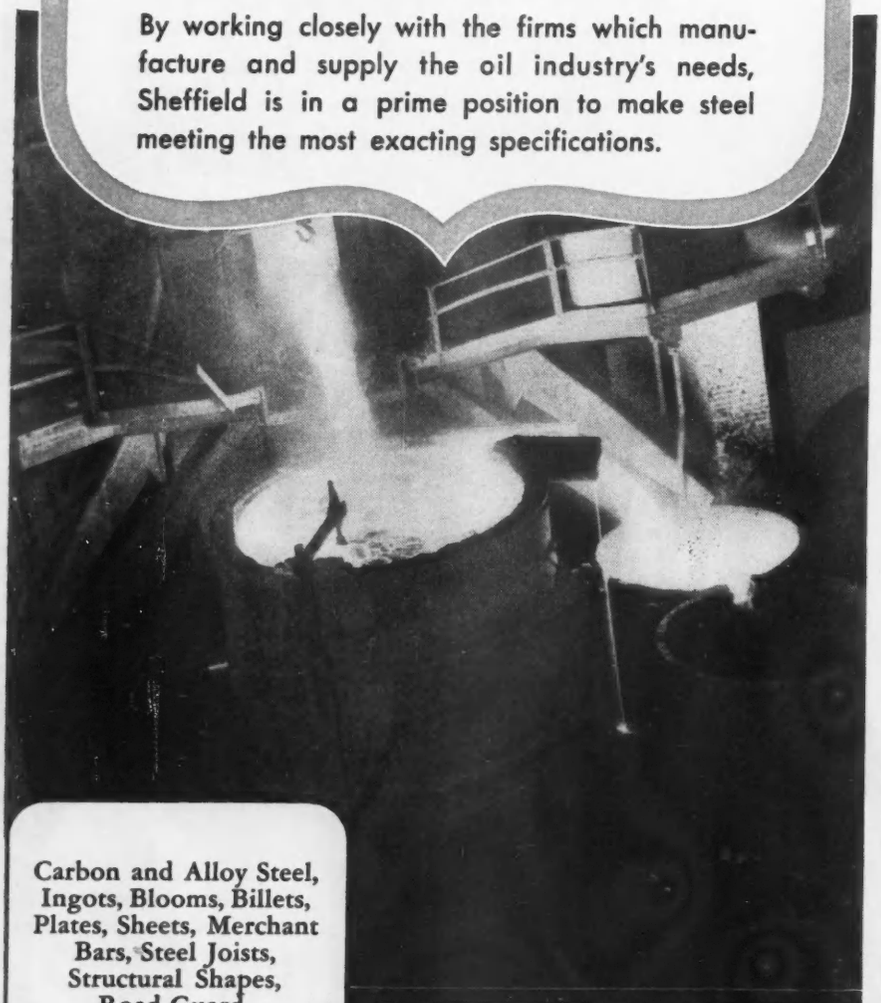

FLOOR STAND WITHOUT INDICATOR
GATE VALVES WITH BEVEL GEARING— (Up to 24" incl.)
PITTSBURGH VALVES
with gearing and other accessories
HYDRO-LUBE PLUG VALVES WITH WORM GEARING— (Up to 8" incl.)
GATE VALVES WITH HAND HOLE— (Up to 12" incl.)
GATE VALVES WITH AN INDICATOR (Up to 12" incl.)
PITTSBURGH
SINCE 1902
PITTSBURGH VALVE & FITTINGS CORP.
BARBERTON, OHIO, U.S.A.

STEEL

From The Hearths Of The Oil Country!

From the open hearths and mills of Sheffield Steel, strategically located in America's greatest oil production area, comes steel for the oil industry. Sheffield steel makers and technicians, long experienced and familiar with requirements, make hundreds of different types and shapes of steel to specifications in Sheffield mills at Houston and Kansas City. Semi-finished and finished products are supplied to manufacturers of oil field equipment and distributors of steel products.

By working closely with the firms which manufacture and supply the oil industry's needs, Sheffield is in a prime position to make steel meeting the most exacting specifications.



Carbon and Alloy Steel, Ingots, Blooms, Billets, Plates, Sheets, Merchant Bars, Steel Joists, Structural Shapes, Road Guard, Reinforcing Bars Welded Wire Mesh, Wire Products, Wire Rods, Fence, Spring Wire, Nails, Rivets, Grinding Media, Forgings, Track Spikes, Bolt and Nut Products

SHEFFIELD STEEL
CORPORATION
HOUSTON KANSAS CITY TULSA

DISTRICT SALES OFFICES: Chicago, Ill.; St. Louis, Mo.; Des Moines, Ia.; Omaha, Nebr.; Wichita, Kans.; Denver, Colo.; Oklahoma City, Okla.; Dallas, Tex.; San Antonio, Tex.; Lubbock, Tex.; El Paso, Tex.; New Orleans, La.; Shreveport, La.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

L. B. Meaders

Harry P. Conroy

Three Halliburton Regional Managers Are Elected Company Vice Presidents

Harry P. Conroy, L. B. Meaders and Fred R. Whitten have been named vice presidents of the Halliburton Oil Well Cementing Company. The three officials have been Halliburton's regional managers and will continue to manage their respective regions in addition to becoming more active in shaping the company's general policy.

Fred R. Whitten

Conroy manages Gulf Coast operations in South Texas, Southwest Texas and South Louisiana; Meaders manages the Central region comprising North Louisiana, East Texas, Central Texas, West Texas-New Mexico and California divisions; Whitten is in charge of the Northern region comprising the Rocky Mountain, Oklahoma, Kansas and Eastern U. S. division.

Hughes Tool Establishes Canadian Corporation to Service Equipment

Hughes Tool Company has formed a Canadian corporation, Hughes Tool Service Limited, with headquarters in Calgary, Alberta, Canada. A group of Hughes sales executives made an extended trip to Canada to set up operations, increasing personnel with Canadian citizens.

The company is constructing its own main warehouse in Edmonton and will lease rock bits through its authorized distributors patterned after their U. S. operations, with stocks maintained at strategic points.

Through the policy of leasing Hughes bits, the field organization of Hughes Tool Service Limited will examine worn bits and study drilling problems affecting bit wear and performance. When unusual performance occurs, bits are frequently returned to the research and engineering laboratories in Houston together with field engineering reports for further examinations.

H. E. Snelson, a Canadian, formerly Rocky Mountain division engineer, has been made Canadian district manager.

Officers of the Hughes Tool Service Limited are M. E. Montrose, president, Houston; W. L. Hunter, vice president, Oklahoma City; F. E. Jacobs, treasurer, Houston; and R. T. Helmer, secretary, Calgary.

be sure... be safe

USE *GENUINE* GARDNER-DENVER PARTS

look for this seal

only Gardner-Denver parts are engineered especially to match the high quality of Gardner-Denver slush pumps

only Gardner-Denver has the authoritative knowledge to give you maximum value in materials and design

only Gardner-Denver has a vital interest in helping you maintain your Gardner-Denver slush pump at peak efficiency

only by insisting on Gardner-Denver genuine parts can you be assured *protected production* . . . the power and stamina for which Gardner-Denver slush pumps are famous.

GARDNER-DENVER TRAINED SERVICE MEN ARE READILY AVAILABLE TO INSTALL GARDNER-DENVER PARTS

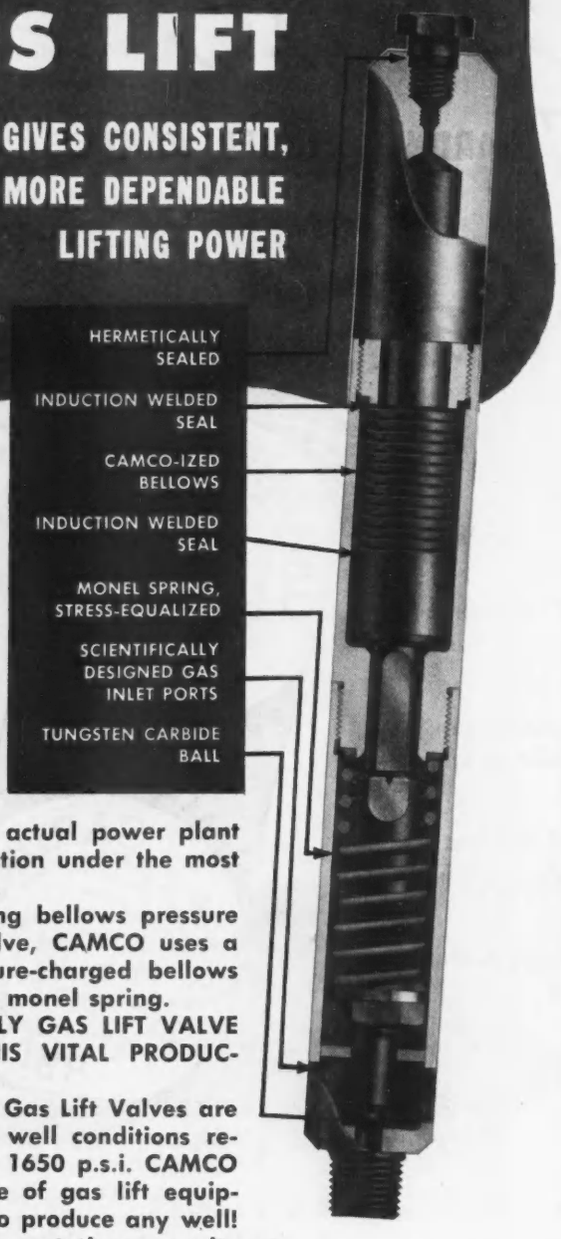
Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada) Ltd., Toronto, Ontario

Dallas • Houston • Tulsa • St. Louis • Los Angeles • San Francisco
New York • Chicago • Pittsburgh • Denver • New Orleans
Continental Supply Co., Continental Bldg., Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y.
Republic Supply Co. (of Calif.) 2600 S. Eastland Ave., Los Angeles, Calif.

GARDNER-DENVER SINCE 1859

CAMCO
GAS LIFT

CAMCO-IZING GIVES CONSISTENT, MORE DEPENDABLE LIFTING POWER



CAMCO-IZING . . . an exclusive CAMCO process . . . is the only answer to consistent, dependable lifting power and economical gas-fluid ratios available in gas lift equipment today.

CAMCO-IZING preforms the valve bellows with 5,000 lbs. differential pressure. Thus, it tests while it conditions the valve's actual power plant for correct, positive action under the most severe well conditions.

And instead of using bellows pressure alone to close the valve, CAMCO uses a combination of pressure-charged bellows and a stress-equalized monel spring.

CAMCO IS THE ONLY GAS LIFT VALVE WHICH PROVIDES THIS VITAL PRODUCTION INSURANCE.

Hundreds of Camco Gas Lift Valves are installed today under well conditions requiring from 125 thru 1650 p.s.i. CAMCO makes a complete line of gas lift equipment . . . equipment to produce any well! Ask your Camco Representative or write Camco, Inc., 1108 Scanlan Bldg., Houston, for help with your production problems.

Your copy of the new Camco Catalog is now ready. Write for it today

CAMCO

GAS LIFT EQUIPMENT AND SERVICE

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Arthur A. Leschen

Douglas W. Vernon

Leschen & Sons Elects President, Vice President-General Manager

A. Leschen & Sons Rope Company, St. Louis, Mo., announced the election of Arthur A. Leschen as president, and Douglas W. Vernon as vice president and general manager.

Leschen joined the company in 1902 after attending Washington University. He is a grandson of Adolph Leschen, who founded the company in 1857, and the brother of Harry J. Leschen, who was president of the company from 1915 to 1942. Since 1943 Leschen has served as vice president in charge of production. He succeeds the late William C. Henning.

Vernon became associated with the Leschen Company in 1945 as general manager of sales. In 1947 he was elected vice president in charge of sales. In addition to his new duties as general manager he will continue to direct the activities of the Sales department.

Geolograph Company Appoints Burns District Manager at Bakersfield

W. J. (Bill) Burns has been named district manager of the Geolograph Company's office at Bakersfield, Calif. He attended Tulsa University prior to employment with Schlumberger Well Surveying Company and Eastman Oil Well Survey Company. Since April, 1948, he has worked out of the Oklahoma City office of the Geolograph Company.

W. J. Burns

Frank High has been transferred from Oklahoma City to Wichita Falls, Texas, to assist Rex Ballinger, district manager.

A. J. Shorney, formerly of Shawnee, Okla., has joined the staff at Oklahoma City.

O-C-T Products Will Be Marketed By Canadian-Vickers of Montreal

The Oil Center Tool Company, Houston, announced that it has entered into an agreement with Canadian-Vickers, Ltd. of Montreal, Canada, which will allow the Canadian firm to manufacture and sell Oil Center Tool Company products to the Canadian oil field market.

The Oil Center Tool Company has made available to Canadian-Vickers organization technical help and advice to insure that Canadian-O-C-T products meet material specifications and inspection requirements for O-C-T products.

PROOF - *not Guesswork*

Makes FWD America's Foremost Heavy-Duty Truck

Here's actual operating proof in oil field service. This FWD is doing an everyday job — speeding over the road to location. Yes — the extra power and speed you need to get equipment where you want it . . . get it there quickly . . . and get it there safely are built into every FWD Four and Six Wheel Drive Truck. What's more, you know this before you buy. And here's why. Every FWD must pass a gruelling 50-mile road test at FWD's proving ground before leaving the factory. *No wonder many of the world's leading oil field operators standardize on FWDs — with individual fleets of over 600 units!*

WHAT FWDs DO ON THE PROVING GROUND
1 Highball over hilly curved roads!
2 Slog thru mud — up to the bumper!
3 Speed over 100-ft. unbanked circle!
4 Twist over ditches —18 inches deep!
5 Drive up 6% grade thru 3-ft. of sand!
6 Climb 70% grade from dead stop!
7 Climb 8-in. beam from standstill!
8 Drill pole holes to prove equipment!
9 Speed safely over level highways!

This is FWD's proving ground. This is your assurance that the FWD you select has the stamina to insure long life without expensive mechanical breakdowns.

An FWD takes the 50-mile road test at the proving ground. For all the facts on FWD Trucks, see your FWD distributor — or write direct.

An Invitation To Truck Buyers

We invite you to watch FWDs pass a series of rigid performance tests. Ask your FWD distributor to arrange your visit to our plant. Or — if you can't get away, ask him to show you the movie, *The FWD Story*. In either case, you will see for yourself how FWD trucks can help solve your heavy-duty trucking problems.

Walter A. Olson
President
The Four Wheel Drive Auto Company

THE FOUR WHEEL DRIVE AUTO COMPANY
Clintonville, Wis. • *Canadian Factory:* Kitchener, Ontario
FOUR AND SIX WHEEL DRIVE TRUCKS

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America's Foremost Heavy-Duty Truck

Travel East via Chicago

on the Texas Chief

A. P. I. Chicago, Nov. 7-11, 1949

Special Streamlined train from Texas

Morning arrival of the Texas Chief allows you to spend a full day in Chicago. Or, if you prefer, you may save your stop-over for your return trip. The Texas Chief conveniently leaves Chicago in the early evening.

A fast, well-planned schedule is just one advantage of this streamliner. You'll also like the convivial lounge car . . . the famous Fred Harvey diner . . . the easy chair comfort of Ridemaster seats and the wide choice of Pullman accommodations. A courteous crew, including a helpful Courier Nurse, brings added enjoyment to your trip.

There's travel pleasure and hospitality aboard this fine train. Try it . . . then you'll agree, the Texas Chief suits your travel needs to a "T".

The only thru streamliner between Texas and Chicago. Leave Houston 8:00 a.m.; arrive Chicago 9:00 a.m. next day.

API SPECIAL

Leave Houston..6:00 pm Nov. 5
Arrive Chicago..7:00 pm Nov. 6

Leave Chicago..2:00 pm Nov. 10
Arrive Houston..3:00 pm Nov. 11

Santa Fe

for reservations: ***P. H. SWINNEY, Div. Pass. Agent, 800 Travis, Houston, or call your local Santa Fe Agent.***

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Lane-Wells Canadian Branch Established; Personnel Announced

Lane-Wells Company, suppliers of technical oil field services, announced the establishment of the Lane-Wells Canadian Company with headquarters in Edmonton. A sales office will be located in Calgary.

The new company was established to meet the rapidly growing demands for technical oil field services in the Alberta fields. Lane-Wells Canadian Company will offer facilities for perforating-bullet and Koneshot, Radioactivity Well Logging, packers, and drillable bridging plugs.

Officers are Rodney S. Durkee, president; N. L. Dorn, Morton T. Higgs, Jas. D. Hughes, C. F. Ludwig, vice presidents; D. S. Jeppson, secretary-treasurer; W. A. Miller and L. H. Ingle, assistant secretaries and assistant treasurers. Ludwig, formerly Gulf Coast division sales manager, is vice president in charge of operations. All other officials are active in Lane-Wells Company.

Ludwig has been associated with the parent firm since 1937. Prior to his appointment as Gulf Coast division sales manager in 1947, he had been district superintendent in the company's Kansas, Corpus Christi and Alice, Texas districts.

Jack Henley will be sales engineer-geologist for Lane-Wells Canadian Company. Henley received his degree in geology from the University of New Mexico in 1941. He joined Lane-Wells Gulf Coast division in June of 1947, as a service representative. Prior to that he had worked for the Humble Oil & Refining Company.

Grant Oil Tool Company Purchases MacClatchie Manufacturing Concern

Henry Salvatori

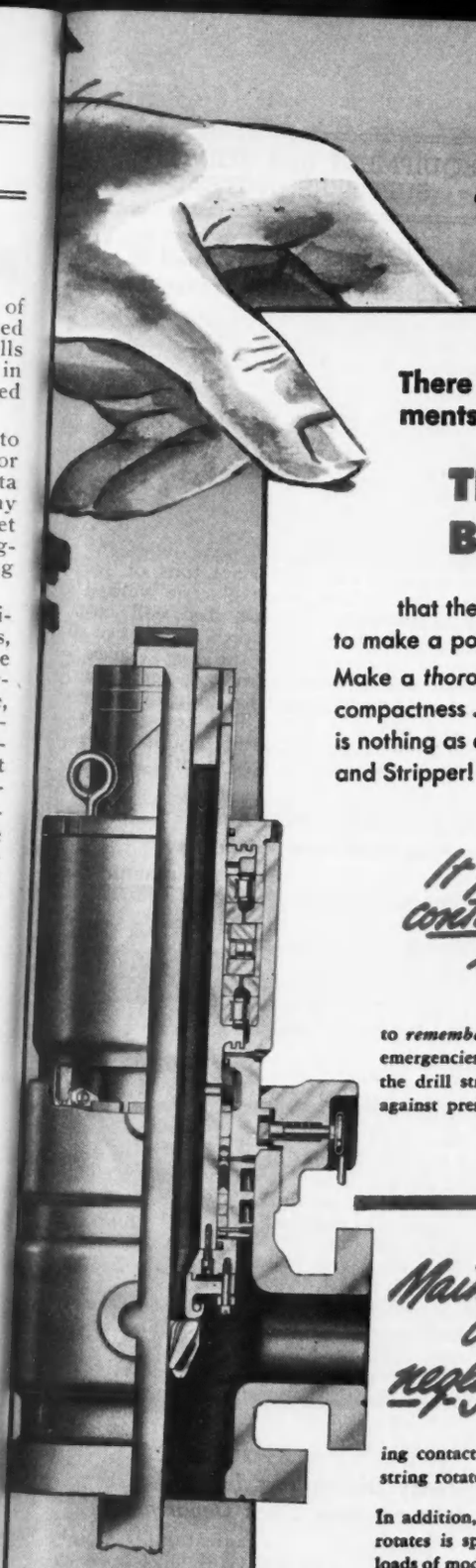
Western Geophysical Company and Grant Oil Company have assumed ownership of MacClatchie Manufacturing Company, Los Angeles, it was announced by Henry Salvatori, president of the companies.

All products manufactured by MacClatchie will continue to be manufactured under the MacClatchie name.

Bethlehem Supply Announces Changes In Field Sales Organization Staff

Bethlehem Supply Company announced the following changes in its field sales organization: W. L. Coleman, former field representative at Seminole, Okla., transferred to Ardmore, Okla., as field salesman; A. M. Taylor, formerly at Oklahoma City, transferred to Seminole as field representative; C. W. Young, a special representative, transferred to Garden City, Kansas; F. M. Matzke, named field representative working out of the Casper, Wyo., store.

We invite you to look it over... check its features...weigh its many advantages for pressure control on today's drilling operations!



There are so *many* performance features, so *many* far-reaching advancements built into . . .

THE SHAFFER COMBINATION ROTATING BLOW-OUT PREVENTER AND STRIPPER

that the only way you can fully appreciate its vital importance to modern drilling operations is to make a point-by-point comparison with *any other similar equipment on the market.*

Make a *thorough* check. Compare operating simplicity . . . fool-proof dependability . . . space-saving compactness . . . and the many other features essential to complete pressure control. You'll find there is nothing as *complete,* nothing as *advanced* as the Shaffer Combination Rotating Blow-Out Preventer and Stripper! Here are just a few of its many advantages . . .

It provides continuous seal!

Because the Shaffer Combination Rotating Blow-Out Preventer and Stripper maintains its leak-proof seal *continuously* while pipe is in the hole, there is nothing to *operate,* nothing to *remember,* nothing to *forget* when sudden pressure emergencies occur. The unit is *always* packed-off around the drill string . . . *always* ready for instant protection against pressure blow-outs!

It seals around any shape!

In addition to maintaining a continuous pressure-tight seal, the stripper rubber in the Shaffer Combination Rotating Blow-Out Preventer and Stripper also expands and contracts *automatically* to fit the various shapes and diameters in the drill string. It seals around square, hexagon and octagon kellys as well as around drill pipe. And, excepting such abnormally large diameters as bits and reamers, the varying diameters of the tool joints, upsets, couplings, substitutes, etc., readily strip through the unit without losing the pressure-tight seal!

Maintenance is negligible!

Because the Stripper Unit and kelly rotate together—not one inside the other—wear on the Stripper Rubber is reduced to a minimum. Moreover, there is no flexing of the Stripper Rubber or loss of sealing contact around the kelly or drill pipe as the drill string rotates, thus assuring a continuous and tight seal.

In addition, the bearing assembly upon which the unit rotates is specially engineered to withstand the severe loads of modern high speed drilling, with separate thrust and radial bearings to carry each type of load. Bearings are lifetime pre-packed with heat-resisting lubricant, further minimizing maintenance!

No Special equipment required!

In addition to its many other advantages, the Shaffer Combination Rotating Blow-Out Preventer and Stripper requires no special kellys or drill strings for its operation. The unit seals off around *any* type of pipe—coupled, upset or flush—with equal efficiency and safety whether the drill string is being raised or lowered, rotated or not. Also, a square, hexagon or octagon kelly may be used—whichever is preferred—and the unit seals automatically and continuously around each type.

What's more, such abnormally large diameters as bits and reamers can be readily passed through the unit by simply pulling a latch and rotating the Bonnet 1/6th turn, whereupon the entire internal mechanism is withdrawn with the bit or reamer. Simply reverse the operation when going back into the hole. It's easy, *quick!*

PLUS MANY OTHER ADVANTAGES—Still other important advantages include unusual *compactness* that saves cellar space . . . Steel Reinforcing Latches that prevent damage to the stripper rubber when pulling large diameters through it—or by excessive well pressures . . . and many other unique advancements that make the Shaffer Combination Rotating Blow-Out Preventer and Stripper the most *efficient,* most *versatile,* most *positive* pressure control unit yet developed. Get *all* the details from your Shaffer representative. Or write direct!

26 years OF OIL TOOL LEADERSHIP

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

...e the compactness and ...licity of the Shaffer Com...ation Rotating Blow-Out ...venter and Stripper. Also ...e its built-in circulation ...ections that further save ...e and simplify hook-ups.

See pages 3843 to 3894 of your 1948 Composite Catalog for information on the complete Shaffer Line.

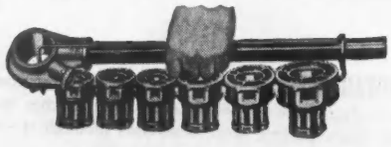
Write for your free copy of the new Shaffer Catalog.

QUICK Get-ready WHEN YOU THREAD 1/8" TO 2" PIPE

RIDGID No. 00R Drop-Head Dies for clean threads fast

● You can't beat the quick get-ready of these little ratchet dies — snap in the size die head you want and its precision-cut tool-steel dies are ready to cut smooth perfect threads. Die heads can't fall out, dies reverse easily for close-to-wall work. Conduit dies on request. Ask your Supply House for work-saver RIDGIDS No. 00R, 111R or 12R.

Free carrier for any set. ➡



RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL CO. • ELYRIA, OHIO

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Consolidated Western Will Build Welded Steel Pipe Mill at Houston

Houston has been chosen as the site for a new electric welded steel pipe mill to be built by the Consolidated Western Steel Corporation, it was announced by Alden G. Roach, president.

Preliminary construction work has begun on property owned by Consolidated Western near the Houston Ship Channel. It is expected that the new plant will be in operation in the spring of 1950.

The new facilities will provide an annual capacity of 100,000 net tons of 24-inch diameter and larger electric welded and expanded steel pipe, and will enable Consolidated Western Steel Corporation to compete in the Texas area, and particularly in the market for large diameter pipe required for long distance oil and gas pipe lines. The new plant's capacity will be approximately 50 miles of large diameter pipe a month.

Day is Manufacturers Agent For Pipe Protective Materials

S. D. Day Company, a manufacturers agency to sell pipe protective materials and related products to the oil and gas industry, has been established by Stephen D. Day, with offices at 2017 West Gray Avenue, Houston.

Stephen D. Day

The company has been appointed Southwest representative for Pittsburgh protective coatings of Pittsburgh Coke & Chemical Company. It also is national distributor for pipe line asbestos felt manufactured by the Ruberoid Company, and represents Griptite anchors and the Stearns electronic detector.

Day was formerly a representative of the Barrett Company and was vice president of Pipe Line Service Corporation.

Stoody Distributors Increased; Johnson Joins Sales Department

The distributor organization of Stoody Company, Whittier, Calif., has been expanded by addition of Mobile Welding Supply Company, Inc., Mobile, Ala.; Morris Wheeler & Company, Inc., Philadelphia; Maine Oxy-Acetylene Supply Company, Auburn, Me.; The Alfred B. King Company, New Haven, Conn.; Fuller Supply Company, Inc., Utica, N. Y.; and Corp Brothers, Inc., Providence, R. I.

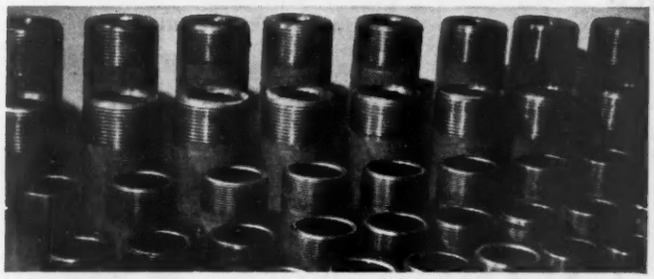
Foreign distributors named to handle Stoody products are Manuel Sigren, Santiago, Chile, who covers the entire country; and Bandeira de Mello, S.A., Rio de Janeiro, who will represent the organization in the central area from Bahia to the state of Santa Catarina.

Amos Johnson has joined the field sales department of the company. Johnson, who will work out of Minneapolis, has been assigned to assist Stoody distributors in Minnesota and the Dakotas.

IMMEDIATE DELIVERY

SINGLE X and DOUBLE X LATHE CUT

SEAMLESS NIPPLES



Manufactured from new seamless tubing, precision machined for taper and bevel, accurately threaded and gauged.

Plastic coating protects threads from rust and damage in handling to guarantee perfect threaded connections.

Sizes: ¼" through 6⅝" in standard lengths. Special sizes, brass, stainless and monel furnished to your requirements.

SOLD ONLY THROUGH SUPPLY STORES

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- Low Cost
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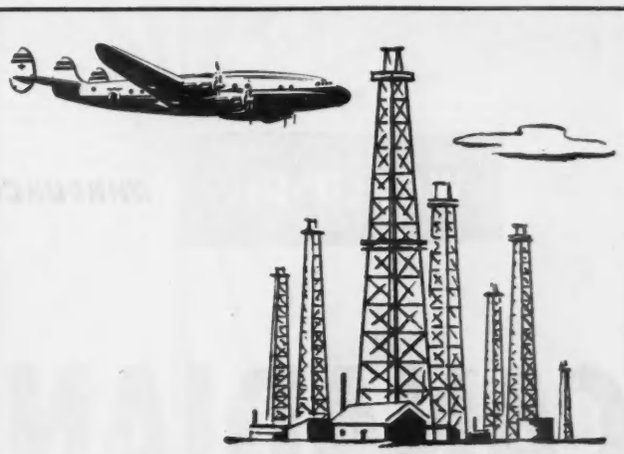
Protect expensive and hard-to-get steel parts from hydrogen sulphide corrosion and corrosive mine and well waters, with Thompson-Hayward Formaldehyde.

Warehouse Stocks Available For Prompt Shipment

THOMPSON-HAYWARD CHEMICAL CO.
DALLAS WICHITA HOUSTON TULSA NEW ORLEANS DENVER SAN ANTONIO



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WORLD OIL *announces its*

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DECEMBER, 1949

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World Oil field editors have been in the area since the thaw, developing exclusive editorial data for this December Canadian issue—touring the fields, visiting on derrick floors, contacting oil company and government officials.

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World Oil will bring western Canada into clear focus, localizing its activities, its operating problems and economics for the widest possible interest of progressive oil men everywhere.

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Check branch of industry

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☐ Producing Company
☐ Pipe Line
☐ Individual Producer
☐ Manufacturing
☐ Supply

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Core Lab South American Base Is Established in Venezuela

Core Laboratories, Inc., Dallas, has established a permanent overseas base point in Venezuela which will operate as a subsidiary organization as Core Laboratories-Venezuela, Inc. Ernest (Mickey) Allen, Jr., a former Core Lab employe who recently completed two years of petroleum reservoir engineering work in South America for Phillips Petroleum Company, will head the new division from offices in Maracaibo.

Ernest Allen, Jr.

Two Executive Appointments Are Announced by Byron Jackson Firm

E. S. Dulin, president of Byron Jackson Company, announced the appointment of O. W. Morgan, Jr., as manager of export sales of the company's Oil Tool Division. Morgan will make his headquarters in New York City in Mid-November. He will also represent the Patterson-Ballagh Division of Byron-Jackson and International Cementers, Inc.

B. A. Hilliard, Jr.

O. W. Morgan, Jr.

B. A. Hilliard, Jr., will succeed to Morgan's position as sales manager of the company's Oil Tool Division. Both Morgan and Hilliard entered the company's employ in the middle 1930's and have much experience in shop and field as well as marketing.

Strikers' Demands Unprecedented, Equipment Manufacturer Declares

Demands made by the International Association of Machinists, on strike at the plants of Wilson Manufacturing Company, Inc., and the Wichita Falls Foundry & Machine Company, Inc., are revolutionary in such an industry, a company spokesman stated. He pointed out the union's demand for a guarantee to each employe of a minimum 40-hour work week, thus obligating the company to pay each employe for 40 hours, whether or not business justified his employment, and whether or not he worked.

Prior to the strike, the companies negotiated with the unions, and reached agreement on all but four points: demands for a 10-cent per hour wage increase, holiday pay, and pay for time spent on jury duty, as well as the minimum work week demand.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

William R. Gottshall

Byron W. Cain

Continental Supply Announces Promotions and New Offices

The Continental Supply Company has appointed William R. Gottshall manager of the Tubular division with headquarters in Dallas. Gottshall has been with Continental since 1936, and was formerly assistant district manager in charge of central and western Oklahoma operations. He is succeeded at that post by Harold J. McMann, formerly district credit manager for the Oklahoma-Kansas district.

J. H. Berry

Byron W. Cain has been named to the new office of assistant comptroller, and will be located in Dallas. Previously an accountant for The Carter Oil Company, Tulsa, and district office manager for Creole Petroleum Corporation in Carpito, Venezuela, Cain started with Continental in February, 1948.

Calgary, Alberta, Canada, is the headquarters for the latest expansion in Continental service. J. H. Berry is managing director. Stores are maintained at Edmonton, with V. H. Von der Lin as manager, and at Lloydminster, Saskatchewan, E. F. Fitzsimonds, manager. The company will operate as The Continental Supply Company, Ltd.

With D. L. Smith as manager, Continental has opened an office in Kanas City, Mo., in the 12th and Walnut Street Building. This office will be under the supervision of R. A. Brewer, district manager, Tulsa.

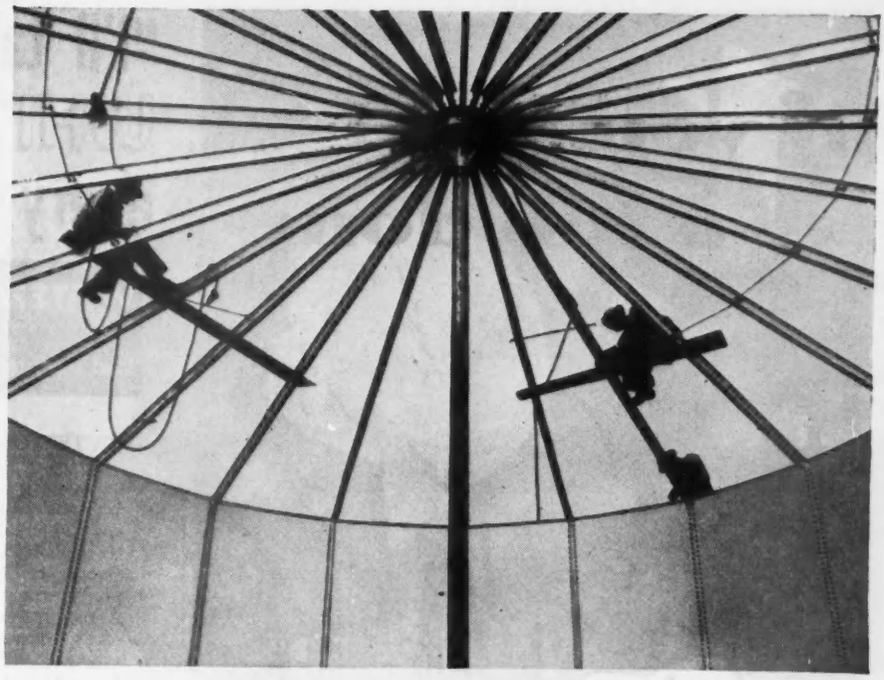
Dean P. Davis has been named manager of Continental's Houston store and warehouse.

D. F. Bell, formerly manager of the El Campo store, has been transferred to Corpus Christi as city salesman. He is succeeded by J. C. Short in El Campo.

C. A. Robison has been appointed manager of the Casper, Wyo. store and B. C. Prowell fills the same position in the store at Artesia, Colo.

Paris Appoints Distributor

Henry H. Paris Distributor, Inc., Houston, has appointed Swan Specialties Company, 521 North Center Street, Casper, Wyo., and Edmonton, Alberta, Canada, as distributor for its products in the Rocky Mountain area and southwest Canada.



EXTRA PRECISION for EASIER ERECTION

Greater exactness in engineering and fabrication of Butler Bolted Tanks make the big difference in the oilfield. With every part die-formed and punched to fit exactly, Butler Tanks can be erected faster and easier—and with assurance that the fit will be oil-tight throughout the tank's long service life.

Butler Bolted Tanks are made according to A. P. I. specifications—but Butler's own requirements demand that every dimension of every part of a Butler Bolted Tank be more exact than the tolerances set by API. That is why Butler Tanks are the choice in the oilfields everywhere. They go up fast, stay tight, last long—and can be quickly dismantled and re-erected on a new site.

Butler's experienced oilfield organization can help show you how to get the maximum service with Butler Bolted Tanks. Call the expert nearest you today.

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STAIRWAYS
UNIT HEATERS

BUTLER MANUFACTURING CO.
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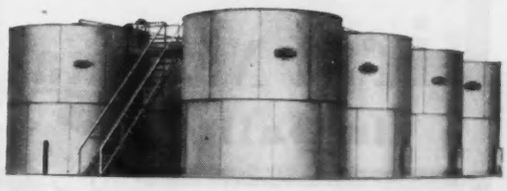

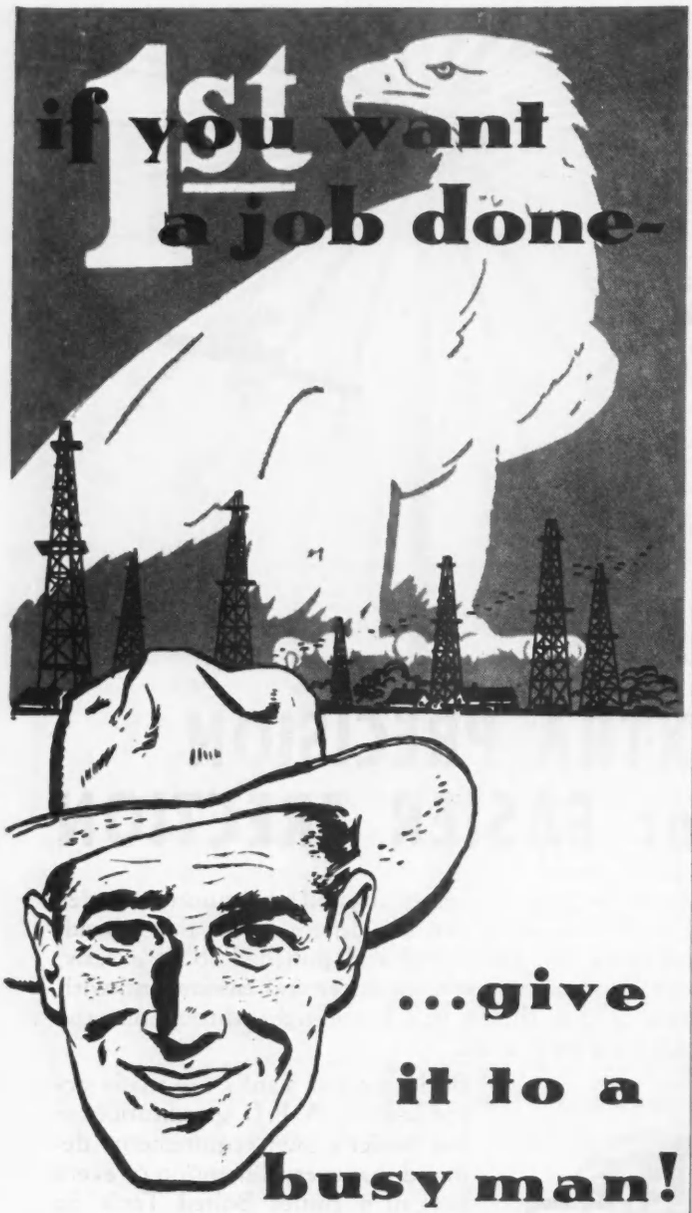

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HOTEL CACTUS
HOTEL MENGER
ANGELES COURTS
VIRGINIA
HOTEL MOUNTAIN LAKE
HOTEL MONTICELLO

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Oil Well Supply Company Announces Personnel Changes and Promotions

C. D. Gammello, manager of the Wooster, O., branch store of Oil Well Supply Company, has been named district material supervisor for the Ohio-West Virginia district, with headquarters at Charleston, W. Va. He is succeeded by B. E. Grey, who has been district representative at Zanesville, O., since April, 1948.

John D. Boggs, Jr., manager of the Eunice, La., branch store, has been transferred to Jennings, La., as store manager and is succeeded by Donald E. Bagby, field representative at Eunice. Boggs was employed by Oilwell in May, 1947, as a storeman in the Houston store and moved to Eunice as store manager the following January. He attended the University of Oklahoma and the University of Hawaii. Since joining Oilwell in September, 1946, Bagby has been located at Eunice, where he was a storeman before becoming field representative.

J. R. Walsh, storeman in the Jennings store since his graduation from Oklahoma A. & M. College in June, 1948, with a B.S. degree, has been named the new field representative at Eunice.

In Texas, John W. Mays has been named manager of the Beaumont store. Mays, storeman in the Houston store since joining Oilwell in February, 1949, was formerly in South America with the Shell Caribbean Petroleum Company.

Establishment of a new district, the Mountain States district, comprising the former Montana and Colorado-Wyoming districts, and opening of a new division inventory control office were announced.

Headquarters for the new district will be in the Treasure State Building, Billings, Mont. District manager will be A. S. Finefrock, manager of the former Montant district and a veteran of 33 years with Oilwell. J. A. Hill, manager of the Colorado-Wyoming district, has been appointed division sales representative with headquarters as Casper, Wyo.

The new division inventory control office is located as Casper, Wyo., and will be under the supervision of T. G. Schoolcraft, who for the past two years has been division office manager for the Rocky Mountain division. He has 16 years service with Oilwell.

Hobbs, Wichita Falls, Shreveport Branches Established by Waukesha

Three new branch stores to serve Eastern New Mexico, North Texas and Western Louisiana have been opened by Waukesha Sales & Service Company. The branches are at Hobbs, N. M., Wichita Falls, and Shreveport. The Hobbs branch will stock Waukesha engines and parts. Wichita Falls and Shreveport branches will provide complete service facilities in addition to complete stocks of Waukesha engines and parts.

F. A. Chance is branch manager at Shreveport; W. W. Wacey is manager of the Wichita Falls branch, and Tom Gatewood is branch manager for the Hobbs store.

WECO
7
FEATURES
MAKE IT YOUR BEST BUY IN SNATCH BLOCKS
FORGED STEEL HOOK . . full swiveling and with extra "beef" at point of greatest stress. Special blunt tip prevents it catching on obstructions.
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CLASSIFIED ADS

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RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. **All classified ads payable in advance.** 10% Discount if 3 or more insertions are ordered at one time. **COPY DEADLINE:** 5th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

LEASES, DRILLING, ACREAGE, ETC.

■ **Recent strikes have focused attention on Montana's deeper oil zones and major companies are moving in fast, drilling and leasing. We buy direct in the field, sell direct to our customers. Write LANDOWNERS ROYALTIES COMPANY, Box 1225, Great Falls, Montana.**

NOTICES

■ BUSINESS CARDS EMBOSSED, Blue or Black Raised Letters, 1,000 for $4.85, Postpaid, Guaranteed Satisfaction, America's Finest Value. Mail copy and check to LYON PRINTERS, 420 Waite Ct., Long Beach 12, California.

ATTENTION

Well established oil well drilling contractor desires to manage and supervise: Individual's, group's, small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired.

Makin Drilling Company

Box No. 131 Phone No. 131

Hobbs, New Mexico

HELP WANTED

■ MECHANICAL ENGINEER. A Texas corporation needs an experienced oil tool design engineer. This man must have outstanding ability, a good employment record, and a capacity to create and develop new ideas. College background desirable. This is a good position with splendid opportunities for advancement. Address: Box 49W, c/o World Oil, Houston, Texas.

MECHANICAL ENGINEER

Thorough university background followed by five or more years of outstanding achievement a definite requirement. Must have creative ability, a precision-technical mind. Men of less ability should not make inquiry. Salary commensurate with rigid requirements. A Missouri corporation. Correspondence confidential. Address: Box 45W, c/o World Oil, Houston Texas.

CORROSION MAN

Must have broad thorough technical education, not less than five years of successful experience. Requirements stiff. Salary in keeping with ability. Address: Box 46W, c/o World Oil, Houston, Texas.

SITUATIONS WANTED

■ WATER FLOODING—Seventeen years general oil field work including 6 years on design, development and operation of secondary recovery way floods Engineering background. Applicant desires to obtain employment by independent leaseholder considering water floods, and wishes to develop so as to provide a predetermined net income over a term of years rather than a high peak and rapidly declining production. Address: Box 50W, c/o World Oil, Houston, Texas.

■ Thirty years experience, production, drilling and Work-over supervising, twenty-two years Gulf Coast. First class references. Free to go anywhere. Address: Box 51W, c/o World Oil, Houston, Texas.

■ Tax accountant, several years specialized training and practical experience in all phases of state and federal income and excise tax work with large producing company. University education, accounting major, under 35. Address: Box 52W, c/o World Oil, Houston, Texas.

FOR SALE

■ **ROTARY equipment almost new, only used few days, 1800' PK rods, Drill collar 30'x4½" with 3½" box, King water swivel 1¼", PK slips, hoist plugs, overshot. Complete outfit $4500 or will divide. We handle new and used spudders, rotaries, core drills, pipe, tools, cable. Fishing tools and equipment rented. Pressey & Son, Pueblo, Colo.**

■ FOR SALE: 1945 Sullivan #200 Mounted on White Truck. Contact James H. Green & Co., Day Phone 9884, P.O. Box 1465, San Angelo, Texas.

■ I have for sale 20 acres in Blanco County, 20 acres in Kendall County and 20 acres in Gillespie County, Texas. These are perpetual deeded royalties and are one-half of the Landowners Royalty. Will sell separate or altogether. For detailed information write W. W. Miner, 2949 Zuni Street, Denver 11, Colorado.

For Sale

120 Type C Foxboro Orifice Meters with piping Mercury and 4 inch Saddles.

10 Type 204 Foxboro Orifice Meters

25 100" 250# Westcott Orifice Meters

3 100" 500# Emco Orifice Meters with Piping

5 No. 3 500# Emco Positive Meters

Pressure Gauges, Fisher and Chaplin-Fulton Regulators. All Equipment in Good Condition.

MILNER OIL AND GAS CO.
Box 457
Okmulgee, Oklahoma

MACHINE TOOLS FOR SALE

5 Bullard Vertical Turret Lathes, 42" tables; 5 Bullard two-head Maxi-mills, 42" tables. All in first class usable condition, complete with motors. Also other machine tools.

The Locomotive Finished Material Co.
Atchison, Kansas

LINE PIPE

Subject to prior sale we offer 200 miles used 10" lapweld 40 lb. line pipe, plain end, bevel 30° for weld, located in Missouri. This pipe is part of 435 mile line replaced by the 22" Ozark pipe line system and was operating at 780 lb. pressure when taken out of service. Dismantling and reconditioning of this pipe is now in progress and available for inspection. Price $1.65 per foot, f.o.b. Missouri shipping points.

Left over from construction of Ozark system, we offer 15,000 ft. new 22" 79 lb. P.E. E.W. line pipe, located near St. Louis, Missouri.

SHELL PIPE LINE CORPORATION
c/o J. B. Thompson
P. O. Box 2648
Houston, Texas
Phone LD-855

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Roberts Acquires Manufacturing, Sales Rights to Shutoff Valve

Harry Roberts, Jr., owner of the Roberts Pipe and Supply Company, Houston, announced that his company has acquired manufacturing and sales rights for the automatic shutoff valve invented by R. E. Meynig. This valve is used as a safety factor on flow lines to protect against commodity loss or damage due to line breakage. This valve, to be known as the Roberts Automatic Shutoff Valve, automatically closes against any pre-determined high or low pressure. If pressure builds up in the line beyond the valve, it will automatically shut off the flow. Also, if a break or leak occurs in the line, the drop in pressure will cause the valve to close.

Harry Roberts, Jr.

Roberts started his pipe and supply business following discharge from the Navy, where he served as an officer during the war. For seven years he was with the Gulf Oil Corporation, in Venezuela. Upon his return to the U. S., he spent several years as a driller and production man, before joining A-1 Bit and Tool Company as district representative in Illinois, Indiana and Kentucky.

Rockwell Annual Report Wins Financial World Survey Award

Rockwell Manufacturing Company, Pittsburgh, was judged as having the best 1948 annual report of the metal products industry in the *Financial World* Annual Report Survey. Weston Smith, executive vice president of *Financial World* and originator of the annual report surveys, presented the bronze "Oscar of Industry" trophy to W. F. Rockwell, Jr., president of the company, at the Annual Awards Banquet in New York.

FOR SALE

■ Sacrifice sale one Ironcraft and five Kelpsch type floating marsh buggies. May be inspected at 2814 Holmes Road, phone LInden 5108 or mail inquiries to 1012 Claxton Street, Houston 17.

Twin Engine C-18a Beechcraft

For sale by owner—Twin Engine C-18a BEECHCRAFT. Excellent condition. Always hangered. Maintained by our licensed A&E. 144 hours right, 246 hours left since last major on engines. Control surfaces just recovered. Beautifully upholstered. Extras include spare engine, ILS, VHF, ADF, 60 watt LF transmitter and receiver, windshield wiper, special overhead radio panel and chemical toilet. Will trade ship plus $15,000 for an acceptable D18 or will sell for cash. For additional information and photos write, wire or call John Duncan, Pilot, Eastman Oil Well Survey Company, P. O. Box 1500, Denver, Colorado, Phone MAin 7151.

WANTED TO BUY

■ WANTED: Mayhew 1000 or Franks KC-45 shot hole drill. Will trade in Franks Model 150 chain pull down in excellent condition. Balance cash. F. R. Findley, P. O. Box 6508, Houston, Texas. Phone JU 1077.

New Books, Maps and Movies

Drilling in the Gulf

A publication consisting of the most valuable articles printed during the past year on rapidly-expanding operations in the Gulf of Mexico, entitled "Off-Shore Drilling Operations in the Gulf of Mexico," has been issued by the insurance firm of Langham, Langston and Burnett.

The carefully-selected articles have been reprinted from leading oil magazines and form a comprehensive review of the economic and technical aspects of what *Fortune* refers to as "the Big Gulf Gamble."

The brochure has photographs and a series of maps of the Gulf Coast region, including a segment of the Langburn Map of offshore lease activity, which will shortly be completed and issued in atlas form. The firm has announced plans to supplement this brochure with additional reprint material from time to time, in recognition of the anticipated development of offshore drilling and production, and the part insurance will play in that development.

Langham, Langston and Burnett Insurance Counselors, 3700 Montrose Blvd., Houston 6, Texas.

Industry Record

The salient statistics of the oil industry through the aftermaths of the world's two greatest wars and the interim period embracing prosperity and depression alike are contained in a compendium published by the Oil Industry Information Committee.

"Petroleum Industry Record—1918-1949" was prepared by the API for the OIIC, not only for oil men, but for teachers, students, researchers, and others needing a reference book on the major statistics of oil.

The tables and graphs portray the progressive development of the oil industry through the past three decades, and the expanding use of petroleum as a source of energy for light, heat, power, transportation and mechanization. The tables and charts, on a year-by-year basis, cover such subjects as crude production and producing wells, drilling activity, proved reserves and allied cumulative figures, refining capacity and runs to stills, average yields per barrel, specialized yields, domestic demand and exports of motor fuels, kerosine and fuel oils, wholesale price indices and world crude production.

J. A. McNally, American Petroleum Institute, 50 West 50th Street, New York 20, 50 cents.

Pumping Equipment

Recommended specifications for cast materials generally used in the manufacture of pumping equipment for the petroleum industry are contained in "Material Specifications for Pumping Equipment," Second Edition.

A specification covering bolts and nuts is included, in addition to specifications on gray iron castings, nickel base austenitic cast iron, carbon and alloy steel castings, bronze castings, and cast nickel copper alloy.

Hydraulic Institute, 90 West Street, New York 6, 50 cents.

Texas Geology

Six figures and six plates, including a geologic map in color, are contained in a 50-page paper entitled "Stratigraphy and Petrology of Buck Hill Quadrangle, Texas," by S. S. Goldich, formerly of the staff of the Bureau of Economic Geology, and M. A. Elms of San Antonio.

The Buck Hill quadrangle is a favorable area for detailed studies of the Tertiary stratigraphy and petrology of the southern Davis Mountains, and this report is based on field investigations carried on in 1936 and 1940 with additional work in 1946. An appendix contains nine detailed measured sections in the quadrangle, and numerous chemical analyses of rocks in the area are included in the text.

Bureau of Economic Geology, The University of Texas, University Station, Box B, Austin 12, Texas, 50 cents; geologic map, 15 cents.

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Expert oil country machinists, using top-quality materials, grind and finish JP Rods and Liners to precision standards.
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JP Fluid Piston Rods are made from the finest rod material available (tensile strength of over 120,000 pounds per square inch) and JP Slush Pump Liners are made from high-grade steel forgings. They are machined and hardened to A.P.I. standards in all stock (and special) sizes to fit any pump.
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WRITE OR WIRE: Complete information regarding stock sizes and prices is available upon request. If you have a "special" job you need in a hurry—give us your specifications.
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HERE'S THE TUBING TONG ROUSTABOUTS LIKE TO USE

Light and Easy to Handle.

Ratchets and Spins Well.

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Easy to Snap On or Off Tubing.

Only One Die to Change When Worn.

Made of heat-treated alloy steel the O'Bannon Tubing Tong is strong but light. It snaps on or off the tubing easily, and is held in position for spinning by strong coil springs.

The body, floating jaw and die arrangement of the tong provides balanced pressure on the tubing so that the harder the tong is bucked, the tighter it grips—with minimum danger of damage to the tubing.

Available for 2", 2½" and 3" tubing and for 2" and 2½" Tubing Couplings.

Ask your O'Bannon representative for a demonstration.

Sold by Supply Stores

WALTER O'BANNON COMPANY
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SQUEAKS from the BULLWHEEL

Wing and a Prayer

"Pilot to tower, pilot to tower. Out of gas at 8000 feet, 30 miles over Atlantic Ocean. Give instructions."

"Tower to pilot, tower to pilot. Repeat after me: "Our Father, who art in Heaven . . .!"

Foul Play

At the football game, the boss suddenly came in behind his office boy, and tapped him on the shoulder.

"So this is your uncle's funeral?" he demanded of the startled youth.

"Looks like it," the quick-witted youngster replied. "He's the referee down there."

Double Trouble

Manager to applicant for bookkeeping job: "Of course you understand double entry?"

Applicant: "Nothing to it. Once I kept books triple entry. One set for the boss, showing the profits, a second for stockholders, showing no profits, and a third for the income tax people, showing a loss."

Better Loose than Tight

"What part of the car causes the most accidents?"

"The nut that holds the steering wheel."

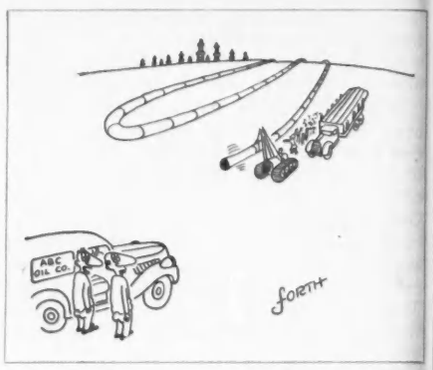
But Tom Had Nine Lives

When a cat gets old and his nose is cold
And the arch in his back is gone,
He sleeps in the sun, for his play is done;
He no longer creeps back at dawn.
He blinks his old eyes—eyes that are wise,
As the young Toms go astray.
But he doesn't lament that his days are spent,
For that is his Tomcat's way.
BUT . . .!
When a man gets old and his blood runs cold,
And he hobbles along with a cane,
He reads all the ads of the monkey gland fads,
And longs for his youth—in vain.
He strolls down to the beaches to watch all the peaches
As they splash in the water blue.
But he hasn't a chance—the gals won't give him a glance—
But a man never knows when he's through.

Stand By, Mr. Carter

Impatient customer: "I'm in a hurry. I want two pounds of liver."

Butcher: "Sorry, ma'am, but there are three ahead of you. You wouldn't want to get your liver out of order, would you?"



"Here they come—back from lunch!"

Practice

"I can't understand how you manage to keep so calm, whatever happens."

"Oh, it's just a matter of training. You see, I've got a wife, three children, two dogs and a cigarette lighter."

Red Top (Hydrostatic) BAILER

A QUICK, POSITIVE LOAD REGARDLESS OF FLUID LEVEL.
Ideal also for fishing small objects—widely used for drilling in (completing) wells, and for drilling cement or plastic plug overages.

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Nothing novel—no bunk, but it gets the job done without scoring brake rims. See pages 3973-3978 Composite Catalog.
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POSITIVE KNOWLEDGE
of just where pipe is stuck, and

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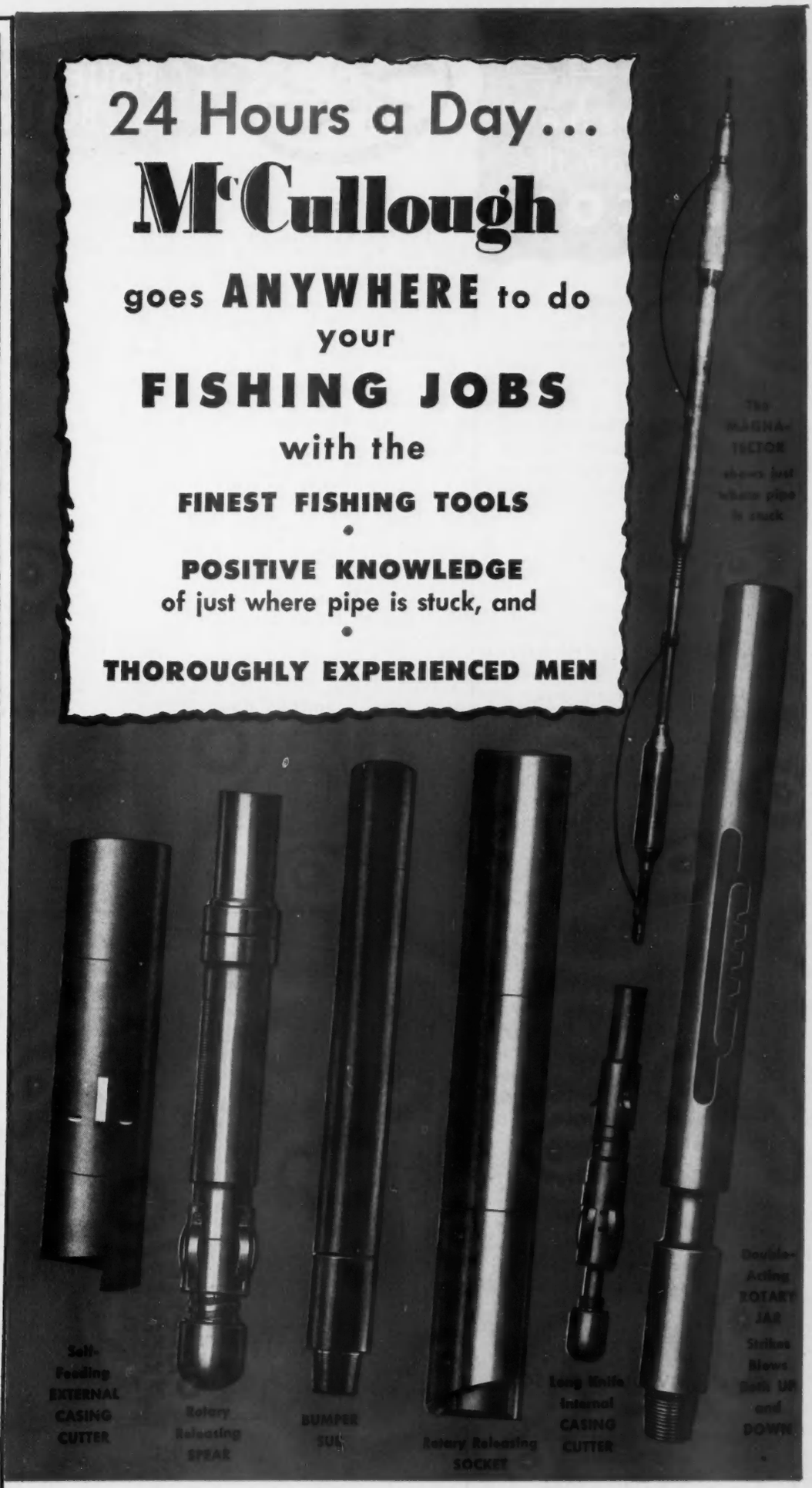

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31
SERVICE LOCATIONS

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30 Rockefeller Plaza
NEW YORK 20, N.Y.

Flashes from the BEACON

WE HEARD recently of an awe-inspiring new household item which converts, by a series of lightning changes, from loveseat to dining table to bed to ironing board. Sounds slick and ingenious as anything . . . and our golden thought for today is a fervent hope we'll never live in quarters close enough to justify purchasing this latest contribution to modern living.

* * *

ALMOST AS VERSATILE — and a great deal less frightening in its technical intricacies—is the old familiar BS&B bolted steel storage tank which is doubling these days on the farm. A series of picture stories in the BS&B BEACON shows the "oilman's standby" in its new role of grain and seed storage unit. No fickleness is involved in this case, however. Bolted tanks are springing up in new oilfields and old in the same profusion as ever. Stepped up and streamlined fabricating techniques account for the "extra" supply.

* * *

VISITORS at BS&B's exhibit during Kansas City's American Royal Livestock and Horse Show, October 14 through 22, received a "Frankenstein" edition of the BEACON as a souvenir. Like the famous monster, the Royal Edition was made up from the bodies of several 1949 editions. *Unlike* Frankenstein's monster, the patchwork BEACON had not destroyed its creator at last report.

* * *

Want the *real* BEACON—for better or worse—each month? It can be had . . . Just a request on your company letterhead will start the BEACON coming to you, without charge, of course.

Write to:

BLACK, SIVALLS & BRYSON, INC.
Industrial and Public Relation Division
720 Delaware
Kansas City, Missouri

SQUEAKS from the BULLWHEEL

Success Story

For the first time, the new sensation of the business world was being interviewed by the press.

"Mr. Wilson," one reporter remarked, "you are truly a self-made man. You have educated yourself while you fought your way up to success. Tell me, how did you manage to get in all that reading during those busy years?"

It was quite simple," Wilson modestly explained. "I kept a good book open on my desk, and read it during those periods when someone said to me over the telephone, 'Just a moment, please.'"

Stick Around

A pink elephant, a green rat, and a yellow snake walked into a cocktail bar. "You're early, boys," said the bartender. "He ain't here yet."

Temporary Insanity

"I was a fool when I married you."

"I realize that now, but at the time I was so infatuated with you that I didn't notice it."

Untimely End

A man was driving an auto with his wife in the back seat and stalled the car on the railroad tracks as the train approached. His wife screamed, "Go on—go on!"

"You've been driving all day from back there," he answered. "I've got my end across . . . now see what you can do with your end."

"The main office plotted the location on their map and that is where it is going to be!"

Trials of Youth

"How old are you, Bobby?" asked the visitor.

"Oh, I'm just at that awkward age."

"Really?" asked the visitor. "And just what do you consider the awkward age?"

"Well," said Bobby, "I'm too old to cry and too young to cuss."

* LANE-WELLS SHAPED-CHARGE PERFORATING-THAT IS!

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